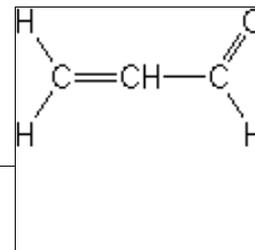


# Acrolein

C<sub>3</sub>H<sub>4</sub>O

CAS\_# 107-02-8

Clear or yellow liquid.



**Other Names** 2-Propen-1-one; 2-propenal; acquinite; Acraldehyde; Acrolein; Acrolein ; acrylaldehyde; Acrylic aldehyde; Allyl aldehyde; aqualine; biocide; crolean; ethylene aldehyde; magnacide; magnacide h; Magnacide H and B; prop-2-en-1-al; prop-2-enal; propenal; Propenaldehyde; propylene aldehyde; slimicide; trans-acrolein;

## Trade\_Names

Physiochemical Properties	Value or Comment	Citation
Solubility in water	In water, 208 g/kg @ 20 deg C and In water, 2.12X10 <sup>+5</sup> mg/l @ 25 deg C	Hazardous Substances Data Bank 2004
Stability	very dependent on pH	Hazardous Substances Data Bank 2004
Inactivation	cytotoxic agent	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
amphibians	LC50: very highly toxic	PAN 2004
aquatic plants	EC50 : injury, mortality, population	PAN 2004
bacteria, algae, crustacea, and fish	Acute EC50 and LC50 values between 0.02 and 2.5 mg/liter, bacteria being the most sensitive species; Inhibition of cell multiplication starts at 0.44 mg/l in protozoa ( <i>Uronema parduczi</i> Chatton-Lwoff); At 0.21 mg/l in bacteria ( <i>Pseudomonas putida</i> ); And at 0.04 mg/l in algae ( <i>Microcystis aeruginosa</i> ). The lowest observed avoidance concn in insects was above 0.1 mg/l for mayfly nymphs ( <i>Ephemerella walkeri</i> ); 0.1 mg/l for rainbow trout ( <i>Salmo gairdneri</i> ). The incipient Median Threshold Limit (TLm) for fathead minnow was 84 ug/l in a flow through bioassay; Inhibition of cell multiplication starts at ... 0.04 mg/l in algae ( <i>Microcystis aeruginosa</i> ).	Hazardous Substances Data Bank 2004
crustaceans	LC50: moderately toxic	PAN 2004
Daphnia magna	LC50 0.23 mg/l/24 hr; 0.083 mg/l/48 hr; No discernible effect conc= 0.034 mg/l. /Conditions of bioassay not specified	Hazardous Substances Data Bank 2004
fish	LC50: highly toxic	PAN 2004
fish	LD50 <i>Carassius auratus</i> (goldfish) <0.08 mg/l/24 hr; LC50 <i>Lepomis macrochirus</i> (bluegill sunfish) 79 ug/l/24 hr /Conditions of bioassay not specified;	Hazardous Substances Data Bank 2004
molluscs	LC50: highly toxic	PAN 2004
phytoplankton	EC50: injury, physiology, population	PAN 2004
Pimephales promelas (fathead minnow)	LC50 14.0 ug/l/96 hr (confidence limit not reliable), flow-through bioassay with measured concentrations, 17.4 deg C, dissolved oxygen 9.3 mg/l, hardness 45.2 mg/l calcium carbonate, alkalinity 42.9 mg/l calcium carbonate, and pH 7.4	Hazardous Substances Data Bank 2004
zooplankton	LC50: highly toxic	PAN 2004

## Environmental Acceptability

Environmental Acceptability	n natural unsterilized water was 29 hours compared with 43 hours in sterilized (thymol-treated) water. Half-life in water at pH 5, 150 hr; at pH 7, 120-180 hr; at pH 9, 5 to 40 hr.: not expected to adsorb to suspended solids and sediment based upon the estimated Koc of 3	Hazardous Substances Data Bank 2004
By Products	Hydrolysis is not expected to occur due to the lack of hydrolyzable functional groups; however primary loss process appears to be an initial hydration (and possibly some biotransformation) to beta-hydroxypropionaldehyde, which is then further biotransformed	Hazardous Substances Data Bank 2004

## Shipboard Use

Storage	Material must be stowed "on deck only" on a cargo vessel and on a passenger vesel carrying a number of passengers limited to not more than the larger of 25 passengers or one passenger per each 3 m of overall vessel length, but the material is prohibited on passenger vessels in which the limiting number of passengers is exceeded. The material must also be stored away from living quarters.	DOT 2002
Storage	Separate from oxidizing materials, peroxides, acids, and alkalis. Store in a cool, dry, well-ventilated location, protected from sunlight. Outside or detached storage is preferred. Inside storage should be in a standard flammable liquids storage warehouse, room, or cabinet. Do not store uninhibited acrolein	Hazardous Substances Data Bank 2004
Handling	Packing Group I: great degree of danger presented	DOT 2002
Handling	Toxic; may be fatal if inhaled, ingested or absorbed through skin. Inhalation or contact with some of these materials will irritate or burn skin and eyes	Hazardous Substances Data Bank 2004

Ventilation	Poison and flammable liquid: "on deck only" storage.	DOT 2002
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**Laws and Regulations**

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

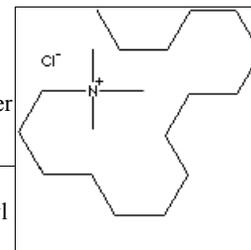
**Citations**

DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> :-
Hazardous Substances Data Bank, , . 2004.	Acrolein	National Library of Medicine Toxnet System :-
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-

## Alkyltrimethylammonium Chloride (ATMAC)

$\text{CH}_3(\text{CH}_2)_{15}\text{N}(\text{Cl})(\text{CH}_3)_3$  CAS\_# 112-02-7

C16 Alkyltrimethylammonium Chloride; cationic surfactant; quaternary ammonium compound; crystalline white powder or clear liquid used as microbiocide and frequently in hair conditioners and fabric softeners



**Other Names** 1-Hexadecanaminium; Cetyltrimethylammonium chloride; Cetyltrimethylammonium Chloride; 1-Hexadecanaminium, N,N,N-trimethyl-, chloride; Hexadecanaminium, N,N,N-trimethyl-, chloride; Cetyl Trimethyl Ammonium Chloride; Cetrimonium Chloride; Palmityltrimethylammonium chloride; Trimethylhexadecylammonium chloride

**Trade\_Names** Adogen 444; Aliquat 6; Arquad 16/28; Arquad 16-29; Arquad 16-50; Barquat CT 29; Cation PB 40; Dehyquart A; Dodigen 1383; Genamin CTAC; Hansaquat 116; HTAC; Intexan CTC 29; Intexsan CTC 29; Intexsan CTC 50; Morpan CHA; NISSAN Cation PB 40; Surfroyal CTAC; Swanol CA 2350; Variquat E 228

Physiochemical Properties	Value or Comment	Citation
Physical State	colorless crystal (alkyltrimethylammonium chloride)	Hazardous Substances Data Bank 2004
pH	6-9	Hansa Chemie AG 2002
Density	1.07 at 20 deg C (alkyltrimethylammonium chloride)	Hazardous Substances Data Bank 2004
Specific gravity	0.971	Hansa Chemie AG 2002
Viscosity	9 mPa*s	Hansa Chemie AG 2002
Solubility in water	very soluble in water; log Kow is -2.17 (alkyltrimethylammonium chloride)	Hazardous Substances Data Bank 2004
Stability	avoid excessive heat	Hansa Chemie AG 2002

Target Organism	Treatment Dosage	Citation
Chlorella pyrenoidosa	96-hour EC50 = 0.22-0.26 mg/L -- 95% confidence	Environmental and Health Assessment 2001
Crustacean Gammarus sp.	48-hour EC50 = 0.08-0.14 mg/L -- 95% confidence	Environmental and Health Assessment 2001
Dunaliella sp.	24-hour EC50 = 0.33-0.45 mg/L -- 95% confidence	Environmental and Health Assessment 2001
Fish	96-hour LC50 = 1-10 mg/L	Hansa Chemie AG 2002
Flatworm Dugesia sp.	48-hour EC50 = 0.58-0.80 mg/L -- 95% confidence	Environmental and Health Assessment 2001
Oligochaete Dero sp.	48-hour EC50 = 0.13-0.36 mg/L -- 95% confidence	Environmental and Health Assessment 2001

### Environmental Acceptability

Environmental Acceptability	if released to water, trimethylbenzylammonium chloride is expected to adsorb to suspended solids and sediments in water	Hazardous Substances Data Bank 2004
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### Shipboard Use

Storage	cool, dry and well ventilated area	Hansa Chemie AG 2002
Handling	liquid irritating to skin and eyes; goggles or faceshield and rubber gloves required	Hazardous Substances Data Bank 2004
Ventilation	vapor irritating to eyes, nose, and throat; harmful if inhaled; vapor may explode if ignited	Hazardous Substances Data Bank 2004

## Laws and Regulations

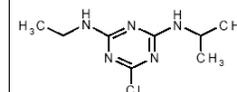
### Citations

Environmental and Health Assessment, , . 2001.	Environmental and Health Assessment of Substances in Household Detergents and Cosmetic Detergent Products	<a href="http://www.mst.dk/udgiv/publications/">http://www.mst.dk/udgiv/publications/</a> : -
Hansa Chemie AG, , . 2002.	EC Safety Data Sheet	<a href="http://www.hansagroup.de/products/pdf/safetysheet/EN-2063.pdf">http://www.hansagroup.de/products/pdf/safetysheet/EN-2063.pdf</a> : -
Hazardous Substances Data Bank, , . 2004.	TRIMETHYLHEXADECYLAMMONIUM CHLORIDE	National Library of Medicine Toxnet System : -

## Atrazine

$C_8H_{14}ClN_5$

**CAS\_#** 1912-24-9



Selective triazine herbicide. White crystalline solid.

**Other Names** 1,3,5-Triazine-2,4-diamine; 6-chloro-N-ethyl-N'-(1-methylethyl)-; 1-Chloro-3-ethylamino-5-isopropylamino-2,4,6-triazine; 2-chloro-4-ethylamine-6-isopropylamino-S-triazine

**Trade Names** Argezin, Atazinax, Atranex, Atrataf, Cyazine, Fenamin, Fenatrol, Candex, Weedex, Weedex A, Zeazine; Aatrex, Aktikon, Alazine, Atred, Atratol, Azinotox, Crisazina, Farmco Atrazine, G-30027, Gesaprim, Giffex 4L, Malermais, Primatol, Simazat, and Zeapos

Physiochemical Properties	Value or Comment	Citation
Solubility in water	33 mg/L in water at 22 deg C;	Hazardous Substances Data Bank 2004
Stability	rate of hydrolysis increases in either acidic or basic waters; resistant to hydrolysis at neutral pH.	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
amphibians	slightly toxic	PAN 2004
annelida	slightly toxic	PAN 2004
aquatic plants	highly toxic	PAN 2004
crustaceans	slightly toxic	PAN 2004
fish	slightly toxic	PAN 2004
molluscs	slightly toxic	PAN 2004
phytoplankton	highly toxic	PAN 2004
zooplankton	slightly toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	half-life in anaerobic wetland was 224 days; at 25 deg C and pH of 4 half life was 244 days, but with 2% humic acid added the half life decreased to 1.73 days. In Great Lakes water, half lives ranged from 340 to 7,900 hours.; may adsorb to suspended solids and sediments; Koc ranges from 54 - 1164.	Hazardous Substances Data Bank 2004
By Products	hydroxyatrazine under anaerobic conditions with no carbon present	Hazardous Substances Data Bank 2004
Inhibitors	adsorption to suspended solids	Hazardous Substances Data Bank 2004
Effectiveness Factor	rate of hydrolysis increases with humic materials	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	shelf life of 3 years in unopened container. Slight sensitivity to light. Keep away from sources of heat, flame, spark.	Hazardous Substances Data Bank 2004
Handling	effects from exposure to substance may include skin irritation, shortness of breath. Rubber gloves and clothing made of cotton recommended. Highly flammable; easily ignited by flame, sparks, heat	Hazardous Substances Data Bank 2004

### Laws and Regulations

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

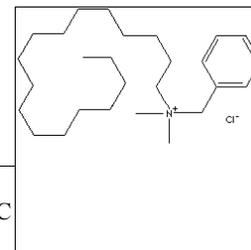
### Citations

Hazardous Substances Data Bank, . 2004.	Atrazine	National Library of Medicine Toxnet System : -
PAN, . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -

## Benzalkonium Chloride

$C_6H_5CH_2N(CH_3)_2Cl$       **CAS\_#** 8001-54-5

white or light yellow/grey solid, or colorless aqueous solution used as a fungicide



**Other Names** alkyl benzyl dimethylammonium chloride; alkyl dimethyl benzylammonium chloride; alkyldimethyl(phenylmethyl) quaternary ammonium chlorides; quaternary ammonium compounds; BTC

**Trade Names** Ammonyx; Arquad B 100; Barquat MB-50; Barquat MB-80; Bayclean; Benirol; Bionol; BTC 824; Bradophen; Catamin AB; Catamine AB; Cequartyl; Dimanin A; Disinall; Drapolene; Drapolex; Enuclene; Germicin; Germitol; Gesminol; Osvan; Paralkan; Parasterol; Reomergal CB; Rodalon; Zephiral; Zephiran; Zephiran Chloride

Physiochemical Properties	Value or Comment	Citation
pH	aqueous solution is slightly alkaline	Hazardous Substances Data Bank 2004
Specific gravity	0.988	Hazardous Substances Data Bank 2004
Solubility in water	very soluble	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
Carp	at oxygen saturation and 500 mg/L Damanin A, survival time was 15 minutes	Hazardous Substances Data Bank 2004
Guppy	at oxygen saturation and 500 mg/L Damanin A, survival time was 19 minutes	Hazardous Substances Data Bank 2004
Zebrafish	at oxygen saturation and 500 mg/L Damanin A, survival time was 14 minutes	Hazardous Substances Data Bank 2004

### Environmental Acceptability

By Products	when heated to decomposition release very toxic fumes (hydrogen chloride and nitrogen oxides)	Hazardous Substances Data Bank 2004
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### Shipboard Use

Storage	hygroscopic	Hazardous Substances Data Bank 2004
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### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and	

	Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

#### Citations

Beveridge, CM, Parr, A. C. S., Smith, M. J., Kerr, A., Cowling, M. J., and T. Hodgkiess. 1998.	The effect of benzalkonium chloride concentration on nine species of marine diatom	Environmental Pollution 103: 31-36
Hazardous Substances Data Bank, . . 2004.	Benzalkonium Chloride	National Library of Medicine Toxnet System : -

## Bromine

Br<sub>2</sub>

CAS\_# 7726-95-6

Inorganic microbiocide. Available as a heavy, mobile, reddish-brown liquid.

**Br — Br**

**Other Names** Bromine; bromine gas

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
pH	6.5 -- 8.5	Lechter 2003
Inactivation	Bromine causes chemical action and cell/protein disruption	Lechter 2003
Inactivation	Production of halogens and injection of ionized air	Stewart 2003

Target Organism	Treatment Dosage	Citation
fish	EC50: behavior, mortality	PAN 2004
fish	LC50: highly toxic	PAN 2004
molluscs	EC50: mortality	PAN 2004
Waterborne microorganisms	Brominated resins: most waterborne microorganisms susceptible to doses up to 2 mg/L as Br <sub>2</sub> ;	Lechter 2003
zooplankton	EC50: intoxication, mortality	PAN 2004
zooplankton	LC50: moderately toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	Bromine at certain concentrations is toxic to certain fresh water and marine species. Acceptable levels for specific applications are not known.	Lechter 2003
Byproducts	Bromine: depending on the type of TTHM formation potential and pH, some brominated organics may form; reduced form of free bromine--bromide ion, Br-	Lechter 2003
Byproducts	Low levels of bromoform, but still below drinking water standards	Stewart 2003

### Shipboard Use

Storage	Keep as cool as reasonably possible; stow clear of living quarters, separated from flammable solids, oxidizers, and radioactive materials.	DOT 2002
Handling	Packing Group I: great degree of danger presented	DOT 2002
Corrosivity	Corrosive Hazard Class of material	DOT 2002
Corrosivity	Bromine is naturally very corrosive but when it is diluted with this system (between 0.2 and 2 ppm), there is no risk of corrosivity.	Lechter 2003
Corrosivity	None	Stewart 2003
Power Requirements	Needs research	Lechter 2003
Power Requirements	< 1,500 KW	Stewart 2003
Ventilation	Corrosive and poison.	DOT 2002
Maintenance	Bromine cartridges need to be periodically changed.	Lechter 2003
Maintenance	Regular visual inspections and reading the maintenance log. Annual change out of Ionz cells and chlorine generators.	Stewart 2003

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Canada	Canada Shipping Act - Part (XV): Pollutant Substances Regulations (CRC, c. 1458)	<a href="http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html">http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>

Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

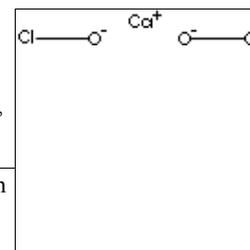
### Citations

DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> : -
Lechter, J, . 2003.	Telephone conversation with Jerry Letcher, Sales Manager	Pentair Water Treatment/Plymouth Products : -
Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Stewart, J, . 2003.	Telephone conversation with Jon Stewart, Vice President of Sales	Marine Environmental Partners : -

## Calcium Hypochlorite



**CAS\_#** 7778-54-3



White or yellowish powder with a strong chlorine odor; hygroscopic and corrosive; used for disinfection, color removal, iron and manganese removal, and taste and odor control.

**Other Names** B-Kpowder; bleaching powder; calcium hypochlorite; calcium oxychloride; hypochlorous acid; calcium salt; losatin; calcium hypochloride; chloride of lime; HTH

**Trade Names** Hyporit; Induclor; Lo-bax; Mildew remover X-14; Perchloron; Pittchlor; Perchloron; Pittabs; Pittclor; Prestochlor; Pulsar; Repak; Stellos; Swim clear

Target Organism	Treatment Dosage	Citation
crustaceans	LC50: highly toxic	PAN 2004
fish	LC50: highly toxic	PAN 2004
molluscs	LC50: highly toxic	PAN 2004
phytoplankton	EC50: growth, mortality, population, physiology	PAN 2004
zooplankton	LC50: moderately toxic	PAN 2004

### Environmental Acceptability

### Shipboard Use

Storage	Material must be stowed "on deck only" on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers or one passenger per each 3 m of overall vessel length, but the material is prohibited on passenger vessels in which the limiting number of passengers is exceeded. Stow the material separated from liquid organic materials, powdered metals and their compounds, ammonia compounds, cyanides, and hydrogen peroxide. Shade from radiant heat and stow away from sources of heat.	DOT 2002
Handling	Packing Group II: medium degree of danger presented; oxidizing substance.	DOT 2002

### Laws and Regulations

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/http://www.myregs.com/dotrspa/</a>

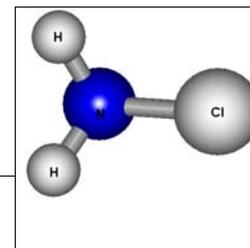
### Citations

DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> :-
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-

# Chloramine



**CAS\_#** 10599-90-3



Chloramines are a mixture of monochloramine, dichloramine, or nitrogen trichloride. Monochloramine is a colorless and unstable liquid. It is the preferred chloramine species for disinfection because of taste and odor problems with the other species. The CAS number, formula, and molecule structure represent monochloramine.

**Other Names** Chloramide; chloramine/chlorine; chloroamide; chloroammonia; monochloramide; monochloroamine; monochloramine; monochloroammonia

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	Liquid	Health Canada 1996
Physical State	liquid	U.S. EPA 1994
pH	Optimum: 7.5-9.0 for monochloramine formation	Health Canada 1996
pH	At pH 8.5 the rate of its formation reaction reaches maximum. Monochloramine is the only chloramine formed when the pH of ammonia containing water is >8 and the molar ratio of hypochlorite to ammonia is <1.	U.S. EPA 1994
Solubility in water	Soluble	Health Canada 1996
Solubility in water	soluble	U.S. EPA 1994
Stability	Stable in freshwater: halflife of up to 10 days. Less stable in seawater: halflife between 2.5 hours to 2.5 days because of reaction with bromide	Oemcke 1999
Stability	Unstable but more stable than chlorine	U.S. EPA 1999
Inactivation	Bacteria attached to surfaces are difficult to inactivate.	Le Chavalier 1984
Inactivation	Inhibition of proteins and/or protein-mediated processes (i.e., respiration).	U.S. EPA 1999

Target Organism	Treatment Dosage	Citation
Asiatic clam	for the juvenile: 1.2 to 4.7 mg/L	U.S. EPA 1999
Bacillus subtilis	Monochloramine was able to induce scissions (strand breaks) in both cell-associated-isolated DNA, with the number of breaks increasing with both disinfectant concentration and contact time.	Shih 1976
Burkholderia pseudomallei	Chlorination may be a satisfactory method for controlling coliforms and preventing growth of B. pseudomallei in potable water.	Howard 2003
Cryptosporidium parvum oocysts	Concentration contact time of 9600 min*mg/L removes 1.7 logs	Oemcke 1999
Cryptosporidium parvum oocysts	80 ppm monochloramine for 90 min achieves 90% inactivation	Korich 1990
E. coli	Given 100 mg/L, 12% reduction with degradation rate of 0.05 mg Cl <sub>2</sub> /L*hr, 7% reduction with degradation rate of 0.02 mg Cl <sub>2</sub> /L*hr, 47% reduction with degradation rate of 0.01mg Cl <sub>2</sub> /L*hr; inactivation rate = 1.0 endotoxin unit (EU)/mL*hr.	Anderson 2003
Enterobacter cloacae	At any given pH, increasing the chlorine-ammonia ratio will increase the inactivation rate. As the pH increased from 6 to 8, the rate decreased by a factor of 5-6.	Ward 1984
F. aquatile	Potential sterilization for these organisms using chlorine. Contact times ranging from 1 to 30 minutes with a corresponding concentration range of 12 to 0.5 mg/L led to complete inactivation.	Gilpin 1985
Giardia cysts	For Giardia cysts: 0.5-log, 1.0-log, 1.5-log-2.0-log, 2.5-log and 3.0-log.310 mg-min/L, 615 mg-min/L, 930 mg-min/L, 1230 mg-min/L, 1540 mg-min/L, and 1850 mg-min/L, respectively.	Cowley 1999
Giardia muris cysts	Concentration contact time of 500-3000 min*mg/L removes 2 logs (99%) when temperatures are 5-15 degrees C and pH is 7.5-9.	Oemcke 1999
Klebsiella pneumoniae	At any given pH, increasing the chlorine-ammonia ratio will increase the inactivation rate. As the pH increased from 6 to 8, the rate decreased by a factor of 5-6.	Ward 1984
Legionella bozemanii	Potential sterilization for these organisms using chlorine. Contact times ranging from 1 to 30 minutes with a corresponding concentration range of 12 to 0.5 mg/L led to complete inactivation.	Gilpin 1985
Legionella pneumophila	Potential sterilization for these organisms using chlorine. Contact times ranging from 1 to 30 minutes with a corresponding concentration range of 12 to 0.5 mg/L led to complete inactivation.	Gilpin 1985
Pseudomonas aeruginosa	Potential sterilization for these organisms using chlorine. Contact times ranging from 1 to 30 minutes with a corresponding concentration range of 12 to 0.5 mg/L led to complete inactivation.	Gilpin 1985
Pseudomonas aeruginosa	At any given pH, increasing the chlorine-ammonia ratio will increase the inactivation rate. As the pH increased from 6 to 8, the rate decreased by a factor of 5-6.	Ward 1984

Viruses	For viruses: 2-log, 3-log, and 4-log; 643 mg-min/L, 1067 mg-min/L, and 1491 mg-min/L, respectively.	Cowley 1999
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### Environmental Acceptability

Environmental Acceptability	Unacceptable: persistence (particularly in freshwater) and toxicity to fish at levels <10 ug/L	Oemcke 1999
Environmental Acceptability	will not react with organic compounds.	U.S. EPA 1999
Byproducts	In seawater, monobromamine forms from reaction of monochloramine with bromide	Oemcke 1999
Byproducts	Diachloroacetic acid and other hydrophilic and large molecular organic halides.	U.S. EPA 1999
Inhibitors	strong oxidizing agents such as bromine, chlorine dioxide, iodine, permanganate, hydrogen peroxide, and ozone (the reduced forms do not interfere)	U.S. EPA 1999

### Shipboard Use

Generation	Can also be produced by adding ammonia to a solution containing free residual chlorine or adding premixed solutions of ammonia and chlorine to water.	Health Canada 1996
Generation	Chloramines are generated by sequential addition of chlorine (hypochlorous acid) and ammonia at a Cl <sub>2</sub> :NH <sub>3</sub> ratio of 3:1 to 5:1. Chloramines must be made on-site.	U.S. EPA 1999
Generation	Chlorine gas + ammonia solid salts or solution at a 5:1 ratio to form monochloramine	Walker 2002
Application	Natural ammonia concentrations will influence dosing.	Health Canada 1996
Application	Normal dose = 1.0-4.0 mg/L; minimum residual in distribution system = 0.5 mg/L; Prevention of nitrification in distribution system = 2.0 mg/L.	U.S. EPA 1999
Storage	Nitrification potential for storing ammonia solution; chlorine gas	Walker 2002
Handling	Acrid monochloramine and dichloramine fumes can cause burning in eyes and throat, cough, nausea, and vomiting. Personal protective equipment should include appropriate gloves, faceshield, and respirator.	Health Canada 1996
Size	Storage, mixing, and pumping requirements	Walker 2002
Ventilation	Fumes generated when producing monochloramine should be vented.	Health Canada 1996
Maintenance	Dosing equipment and pumps	Health Canada 1996

### Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepe.html">http://www.unep.ch/seas/main/nep/nepe.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	

South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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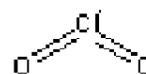
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Korich, DG, JR Mead, MS Madore, NA Sinclair, CR Sterling. 1990.	Effects of Ozone, Chlorine Dioxide, Chlorine, and Monochloramine on <i>Cryptosporidium parvum</i> Oocyst Viability	Applied and Environmental Microbiology 56: 1423-1428
Le Chavalier, ML, TS Hasseneur, AK Camper, GA McFeters. 1984.	Disinfection of Bacteria Attached to Granular Activated Carbon	Applied and Environmental Microbiology 45: 918-
Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
Shih, KL, J Lederberg. 1976.	Effects of chloramine on <i>Bacillus subtilis</i> deoxyribonucleic acid	Journal of Bacteriology 125: 934-
U.S. EPA, , . 1994.	Drinking Water Criteria Document for Chloramines	National Center for Environmental Assessment ECAO-CIN-D002 : -
U.S. EPA, , . 1999.	Alternative Disinfectants and Oxidants Guidance	EPA Report 815-R-99-014 : -
Walker, I, . 2002.	Chloramination -- Future Best Practice for the Water Industry?	<a href="http://www.wreplc.co.uk/downloads">www.wreplc.co.uk/downloads</a> : -
Ward, NR, RL Wolfe, BH Olsen. 1984.	Effects of pH, application, technique, and chlorine-to-nitrogen ratio on disinfectant activity of inorganic chloramines with pure culture bacteria	Applied and Environmental Microbiology 48: 508-

# Chlorine Dioxide

ClO<sub>2</sub>

CAS\_# 10049-04-4

A gas used as a powerful biocide, disinfectant agent, and oxidizer. It is produced and used on location. The liquid and solid forms of chlorine dioxide are extremely unstable and explosive.



**Other Names** Chlorine oxide; chlorine peroxide; anthium dioxide; chlorine (IV) oxide; chloroperoxy; chloryl radical; alcide

**Trade\_Names** doxide 50

Physiochemical Properties	Value or Comment	Citation
Physical State	solid	Raytec Corp 2004
Physical State	gas	U.S. EPA 1999
pH	affects are noted for the generation of the disinfectant but does not influence biocidal properties	U.S. EPA 1999
Solubility in water	high, particularly in chilled water. Remains in solution as a dissolved gas.	U.S. EPA 1999
Stability	Unreactive in its dry form	Raytec Corp 2004
Stability	Decomposes in sunlight. Stable in dilute solution in a closed container in absence of light. Reacts violently with reducing agents and therefore cannot be transported.	U.S. EPA 1999
Inactivation	chlorine dioxide may react with amino acids to alter viral capsid proteins or RNA to impair RNA synthesis. Also can effect physiological functions such as increasing permeability of outer membrane.	U.S. EPA 1999

Target Organism	Treatment Dosage	Citation
crustaceans	not acutely toxic	PAN 2004
Cryptosporidium	For 1-log inactivation, CT values range 100-120 mg-min/L at temp between 5-15 deg C and pH between 6.5-8.5. Not effective at low temps.	Cowley 1999
Cryptosporidium parvum	Approximately 90% inactivation of oocysts after 1 hour of exposure to 1.3 mg/L (using infectivity method).	Korich 1990
Cryptosporidium parvum	30 minute contact time with 0.22 mg/L reduced oocyst infectivity; 3-log inactivation with 2.7 and 3.3 mg/L chlorine dioxide for contact times of 120 minutes at pH of 8 and temp of 22 deg C.	U.S. EPA 1999
Dreissena polymorpha	70% mortality with 5 mg/L in flow-through cooling water systems	Rigby 2001
E. coli and B. anthracis	dosages in the range of 1 - 5 mg/L	U.S. EPA 1999
fish	not acutely toxic	PAN 2004
Giardia cysts	0.5 log inactivation: 4 mg-min/L; 1.0 log inactivation: 7.7 mg-min/L; 1.5 log inactivation: 12 mg-min/L; 2.0 log inactivation: 15 mg-min/L; 2.5 log inactivation: 19 mg-min/L; and 3 log inactivation: 23 mg-min/L at 10 deg C and pH = 6-9.	Cowley 1999
Giardia cysts	60 minute contact time, doses from 1.5 to 2 mg/L provide a 3-log inactivation at 1 deg C and pHs of 6 and 9.	U.S. EPA 1999
molluscs	not acutely toxic	PAN 2004
total coliform and f2 coliphage virus in sewage	initial chlorine dioxide residuals between 0.85 and 0.95 mg/L resulted in 2.8-log inactivation of the total coliform and an average 4.4-log inactivation of the f2 coliphage over a contact time of 240 minutes.	U.S. EPA 1999
Viruses	2-log inactivation: 4.2 mg-min/L; 3-log inactivation 12.8 mg-min/L; 4-log inactivation: 25.1 mg-min/L	Cowley 1999

## Environmental Acceptability

Environmental Acceptability	does not react with organic matter or bromides	Cowley 1999
Environmental Acceptability	More effective than chlorine and chloramines for inactivation of viruses, cryptosporidium, and giardia. May enhance clarification process.	U.S. EPA 1999
Byproducts	No toxic products formed	Cowley 1999
Byproducts	Fewer by-products are generated using the electrochemical method of production.	Cowley 2000
Byproducts	Chlorine dioxide can produce two major by-products: chlorate and chlorite. Newer generators do not produce chlorate.	Oemcke 1999
Byproducts	Reaction of hypochlorous acid with sodium chlorite is sodium hydroxide. Chlorate also undesirable byproduct. Chlorine dioxide reacts with the soluble forms of iron and manganese to form precipitates.	U.S. EPA 1999
Inhibitors	pH and temperature	Cowley 1999

Inhibitors	high pH slows formation of chlorine dioxide and impels less efficient chlorate-forming reactions.	U.S. EPA 1999
Effectiveness Factor	Perstraction membrane isolates the reaction system and passes only ClO <sub>2</sub> and other gasses which produces a high quality product (high conversion efficiency).	Cowley 2000
Effectiveness Factor	Humidity or moisture in the air can start the reaction between the chlorite salt and the proprietary activators impregnated on the solid substrate.	Raytec Corp 2004
Effectiveness Factor	Disinfection efficiency decreases as temp decreases. Suspended matter and pathogen aggregation affect the disinfection efficiency. More suspended matter means less efficiency.	U.S. EPA 1999

### Shipboard Use

Generation	Produced onsite with an electrochemical cell and sodium chlorite; other methods include mixing chlorine gas and sodium chlorite or hydrochloric acid and sodium chlorite or hydrochloric acid, sodium hypochlorite, and sodium chlorite on site.	Cowley 1999
Generation	Electrolytic process that converts sodium chlorite solution to chlorine dioxide.	Halox Technologies 2003
Generation	When the dmClO <sub>2</sub> comes in contact with water or is exposed to moisture a reaction occurs between the chlorite salts and the proprietary activators that are impregnated on the zeolitic substrate.	Raytec Corp 2004
Generation	Common precursor feedstock is sodium chlorite reacting with gaseous chlorine, hypochlorous acid, or hydrochloric acid. May also use sodium chlorate and hydrogen peroxide and concentrated sulfuric acid. Generally, few DBPs.	U.S. EPA 1999
Application	Dosed on site	Cowley 1999
Application	Requires softened, potable feedwater (~1900 gal/day at max generation).	Halox Technologies 2003
Application	If dosed during ballasting it can be expected to decline to low levels before release.	Oemcke 1999
Storage	Requirements for sodium chlorite solution (25% w/w), dosing tank, and electrochemical cassettes (6-month shelf-life).	Halox Technologies 2003
Storage	Loose powder or sachets must be kept dry to eliminate activation and production of ClO <sub>2</sub> .	Raytec Corp 2004
Storage	Cannot be compressed or stored as a gas.	U.S. EPA 1999
Handling	Can lead to production of noxious odors	U.S. EPA 1999
Size	2'x 4' for generating equip + dosing tank + storage.	Halox Technologies 2003
Corrosivity	Negligible	Raytec Corp 2004
Corrosivity	Corrosive effects on steel	Rigby 2001
Power Requirements	~ 4 kW operating at max capacity (5.2 lbs can be generated per day with Halox 2000 system with 4 cassettes).	Halox Technologies 2003
Ventilation	Hydrogen gas needs to be vented from cathode.	Cowley 2000
Maintenance	Every 2000 hours of operation.	Halox Technologies 2003
Limits	Forbidden from transporting as material; must be generated onsite.	DOT 2002
Limits	Catholyte product waste stream	Halox Technologies 2003

### Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nep/pape.html">http://www.unep.ch/seas/main/nep/nep/pape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>

Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> :-
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Halox Technologies, , . 2003.	Halox Technical Data Sheets	<a href="http://www.haloxtech.com">www.haloxtech.com</a> :-
Korich, DG, JR Mead, MS Madore, NA Sinclair, CR Sterling. 1990.	Effects of Ozone, Chlorine Dioxide, Chlorine, and Monochloramine on <i>Cryptosporidium parvum</i> Oocyst Viability	Applied and Environmental Microbiology 56: 1423-1428
Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-
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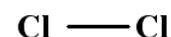
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U.S. EPA, , . 1999.	Alternative Disinfectants and Oxidants Guidance Manual	: -

# Chlorine



CAS\_# 7782-50-5

A highly reactive gas used to remove color and disinfect water.



**Other Names** Bertholite, warfare gas, chloor (Dutch), chlore (French), chlor (German)

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	greenish-yellow, diatomic gas	Hazardous Substances Data Bank 2004
pH	persists as an element only at a very low pH (less than 2), and at the higher pH found in living tissue it is rapidly converted into hypochlorous acid.	Hazardous Substances Data Bank 2004
Specific gravity	1.564	Hazardous Substances Data Bank 2004
Solubility in water	Soluble in water at 25 deg C, more soluble in alkalis	Hazardous Substances Data Bank 2004
Inactivation	Bacteria and protozoa: breaches the cell wall and attacks nucleus; Viruses: attacks the DNA	Bolek 2003

Target Organism	Treatment Dosage	Citation
annelida	LC50: moderately toxic	PAN 2004
Baetis harrisoni	24 h LC50 - 11.2 and 10.1 ug/L; 48 h LC50 - 5.0 and 6.5 ug/L; 96 h LC50 - 4.1 and 4.8 ug/L.	Williams 2003
Centroptilium spp.	24 h LC 50 - 71 ug/l, 46 ug/l (8 h), and 502 ug/l (8 h); 48 h LC50 - 27 and 93 ug/L;	Williams 2003
Ceriodaphnia dubia	24 h LC50 - 5 ug/L (hypochlorous acid), 6 ug/L (hypochlorite ion), 16 ug/L (monochloramine), and 27 ug/L (dichloramine).	Williams 2003
crustaceans	LC50: highly toxic	PAN 2004
D. polymorpha (freshwater mussel)	continuous 1 mg/L mortality in 588 hours	Rajagopal 2003
Daphnia magna	24 h LC50 140 ug/L; 48 h LC50 - 116 ug/L	Williams 2003
Daphnia magna	48 h LC 50 - 45 ug/L and 17 ug/L	Williams 2003
fish	LC50: highly toxic	PAN 2004
Giardia cysts	17 mg-min/L, 35 mg-min/L, 52 mg-min/L, 69 mg-min/L, 87 mg-min/L, and 104 mg-min/L, respectively.	Cowley 1999
Hexagenia spp	48 h LC 50 - 357 ug/L	Williams 2003
M. Eduli (marine mussel)	continuous 1 mg/L mortality in = 966 hour	Rajagopal 2003
M. Leucophaeata (brakish water)	continuous 1 mg/L mortality within 1104 hours	Rajagopal 2003
Micrororganisms, ghiardia, cryptosporidium	Depends on what is in the water. Ranges from 0.5 ppm to 50 ppm.	Bolek 2003
molluscs	LC50: highly toxic	PAN 2004
Pteronarcys spp	96 h LC50 400 ug/L	Williams 2003
Stenonema ithaca	96 h LC50 - 102 ug/L	Williams 2003
Viruses	For Giardia cysts: 0.5-log, 1.0-log, 1.5-log, 2.0-log, 2.5-log, and 3.0-log. for viruses: 2-log, 3-log, and 4-log; 3 mg-min/L, 4 mg-min/L, and 6 mg-min/L, respectively.	Cowley 1999
zooplankton	LC50: highly toxic	PAN 2004

## Environmental Acceptability

Byproducts	Chlorine will produce trihalomethanes, haloacetic acid	Bolek 2003
Effectiveness Factor	The time taken for 100% mortality of mussels decreased with increasing chlorine concentration. Chlorine serves as an excellent biocides for controlling biofouling in cooling water systems, its use is restricted due to environmental considerations, Efficacy of chlorine as an antifoulant depends on various parameters, most importantly residual levels of chlorine and contact time.	Rajagopal 2003

## Shipboard Use

Storage	Material must be stowed "on deck only" on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers or one passenger per each 3 m of overall vessel length, but the material is prohibited on passenger vessels in which the limiting number of passengers is exceeded. This material must also be stowed clear of living quarters, and separated from acetylene, ammonia, diborane, hydrogen, and radioactive material.	DOT 2002
Corrosivity	Chlorine can be corrosive. System uses approximately 0.4-0.8% chlorine in the solution to prevent corrosion.	Bolek 2003
Power Requirements	Small system: 220V AC Large system: 480V AC	Bolek 2003
Ventilation	Poisonous gas and must be stowed on deck.	DOT 2002
Maintenance	Periodic preventative maintenance, loading brine tank, keeping recording logs	Bolek 2003

## Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Canada	Canada Shipping Act - Part (XV): Pollutant Substances Regulations (CRC, c. 1458)	<a href="http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html">http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/ereg-112.rrr.html">http://sedac.ciesin.org/entri/register/ereg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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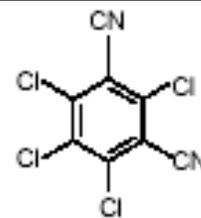
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Dychdala, GR, . 1991.	Chlorine and Chlorine Compounds	Disinfection, Sterilization, and Preservation. S.S. Block (Ed.) : -
Hazardous Substances Data Bank, , . 2004.	Chlorine	National Library of Medicine Toxnet System : -
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Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Rajagopal, S, GV Velde, M VDG Gaag. HA Jenner. 2003.	How Effective is intermittent chlorination to control adult mussel fouling in cooling water system	Water Research 37: 329-338
Rajagopal, S, Van der Velde, G., and H, A. Jenner. 2002.	Effects of low-level chlorination on zebra mussel, <i>Dreissena polymorpha</i>	Water Research 36: 3029-3034
Williams, ML, CG Palmer and AK Gordon. 2003.	Riverine macroinvertebrate responses to chlorine and chlorinated sewage effluents - Acute chlorine tolerances of <i>Baetis harrisoni</i> (Ephemeroptera) from	Water SA 29: 483-

## Chlorothalonil



**CAS\_#** 1897-45-6

White crystalline solid, used as a fungicide effective against a broad range of plant pathogens attacking many agronomic and vegetable crops. Also used as a preservative in paints and adhesives.



**Other Names** 1,3-Benzenedicarbonitrile, 2,4,5,6-tetrachloro-; 2,4,5,6-Tetrachloroisophthalonitrile;

**Trade\_Names** Daconil 2787; Bravo; Sweep; Vanox

Physiochemical Properties	Value or Comment	Citation
Solubility in water	IN WATER @ ROOM TEMP 0.6 PPM; Solubility (25 deg C): 0.6 mg/kg water	Hazardous Substances Data Bank 2004
Stability	will readily biodegrade under aerobic and anaerobic conditions in aquatic ecosystems; DOES NOT HYDROLYZE IN MODERATE ALKALINE OR ACIDIC MEDIA	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
amphibians	LC50: highly toxic	PAN 2004
clams	LC50 Mya arenaria clams 35.0 5.9 mg/l/96 hr /Bravo 500; conditions of bioassay not specified; LC50 Mytilus edulis (blue mussels) 5.9 mg/l/96 hr; conditions of bioassay not specified; LC50 Rainbow trout 76 ug/l/96 hr /Technical chlorothalonil; conditions of bioassay not specified	Hazardous Substances Data Bank 2004
crustaceans	LC50: very highly toxic	PAN 2004
Fish	LC50: very highly toxic	PAN 2004
fish, aquatic invertebrates	47-84 ppb is highly toxic to fish; may affect fish populations at low levels (3 - 6.5 ppb). aquatic invertebrates and may affect their reproduction at low conc (> 79 ppb)	Hazardous Substances Data Bank 2004
molluscs	LC50: slightly toxic	PAN 2004
phytoplankton	EC50: accumulation, population	PAN 2004
zooplankton	LC50: moderately toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	Half-life of 38.1 days in aqueous media at pH 9; Koc value of 1,800(6) indicates adsorption from the water column to sediment and suspended material may occur	Hazardous Substances Data Bank 2004
Environmental Acceptability	anaerobic half life <0.5 days	Thomas 2003
Byproducts	At pH 9, chlorothalonil in water may hydrolyze to 4-hydroxy-2,5,6-trichloro-isophthalonitrile and 3-cyano-2,4,5,6-tetrachlorobenzamide;	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	Keep in cool, dry, ventilated place	Hazardous Substances Data Bank 2004
Handling	Use gloves, apron, rubber or plastic boots; use mask for powders	Hazardous Substances Data Bank 2004
Corrosivity	Non-corrosive	Hazardous Substances Data Bank 2004
Ventilation	required	Hazardous Substances Data Bank 2004

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>

Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
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USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
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Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Thomas, KV, M McHugh, M Hilton, M Waldoock.. 2003.	Increased persistence of antifouling paint biocides when associated with paint particles	Environmental Pollution 123: 153-161

## Copper Ions



**CAS\_#** 15721-63-8

Algicide, toxic to heterotrophic bacteria in aquatic environments and has been used to control poliovirus; electrolytically generated



**Other Names**  
**Trade Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	aqueous solution	Hazardous Substances Data Bank 2004
Inactivation	The presence of the high $\text{Cu}^{2+}$ concentration in the culture medium induced the morphological changes of the organism.	Gardea-Torresdey 1997
Inactivation	decrease in photosynthesis activity	Gustavson 1995
Inactivation	Neither bacterial nor phytoplankton viability appeared to be affected. Some influence on viability of zooplankton and dinoflagellate cysts. Effects may have resulted from inordinately high copper concentrations.	Rigby 2001

Target Organism	Treatment Dosage	Citation
	Freshwater: 33% effective at 167 ppb. Seawater (simulated): 70% effective at 68 ppb.	Gracki 2002
amphibians	LC50: very highly toxic	PAN 2004
crustaceans	LC50: highly toxic	PAN 2004
echnoderms	LC50: very highly toxic	PAN 2004
fish	LC50: moderately toxic	PAN 2004
Freshwater crayfish	LC50: 0.83 mg/L for 96 hours; 4.07 mg/L for 24 hours (intermoult adult male)	Oemcke 1999
Gymnodinium catenatum cysts	200 mg/L was ineffective for inactivation	Oemcke 1999
marine benthic community	LC50: highly toxic	PAN 2004
Microalgal communities	Concentration in the enclosure area: the copper concentration varied from 0.013 to 0.007 $\mu\text{M}$ (low Cu), 0.087 to 0.032 (medium Cu), 0.205 to 0.157 (high Cu). A decrease in photosynthesis activity was observed when exposed to low and medium Cu, a drop of about 50%. For high Cu, a drop of less than 10%. The photosynthesis activity is not affected by the highest Cu anymore.	Gustavson 1995
molluscs	LC50: moderately toxic	PAN 2004
Mucor rouxii		Gardea-Torresdey 1997
nematodes and flatworms	LC50: moderately toxic	PAN 2004
Oocytis nephrocytiodes	A 5 $\mu\text{M}$ copper treatment increased the population from less than 1% in the control to 56%.	Soldo 2000
phytoplankton	LC50: very highly toxic	PAN 2004
zooplankton	LC50: very highly toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	Unsuitable: toxicity to fish if discharged at doses needed for effective inactivation.	Gracki 2002
Environmental Acceptability	Communities that were exposed to copper also showed an increased co-tolerance to zinc, nickel, and silver.	Soldo 2000
Byproducts	Reacts with phosphates to form insoluble precipitate. It also forms complexes and chelates with ammonia, humic acid, and other organics reducing its bioavailability.	Oemcke 1999
Inhibitors	Presence of sediments (settled or suspended) reduces efficacy of copper as a biocide.	Gracki 2002
Effectiveness Factor	Copper reacts with dissolved organic matter; simulated seawater did not have proper amounts of solutes.	Gracki 2002
Effectiveness Factor	> 2 days: Low concentration of $\text{Cu}^{2+}$ --No effect on biomass, photosynthesis activity, or short-term tolerance. Small change in species composition. High concentration of $\text{Cu}^{2+}$ --There is a very strong reduction in biomass and photosynthesis activity. Increased short-term tolerance. Strong change in species composition. 2-14 days: Low concentration of $\text{Cu}^{2+}$ -- There is a decrease in photosynthesis activity. High concentration of $\text{Cu}^{2+}$ --Continuation of the effects seen during the first 2 days. 14-20 days: Low concentration of $\text{Cu}^{2+}$ --Increased tolerance for copper in the short-term test. Co-tolerance for zinc. High concentration of $\text{Cu}^{2+}$ --Increasing biomass and photosynthesis activity. High tolerance for	Gustavson 1995

Effectiveness Factor	copper and co-tolerance for zinc. After 12 weeks of copper exposure to the freshwater periphyton communities, it was found that there was a change in the distribution of algal classes from a community dominated by Cyanophyceae to one dominated by Chlorophyta.	Soldo 2000
Effectiveness Factor	Periphyton communities subjected to long-term exposure at different concentrations did not differ significantly in the photosynthesis rate. Copper exhibits antifouling activity against organisms such as barnacles, tube worms, and the majority of algal fouling species. However, several algal species, such as <i>Enteromorpha</i> spp., <i>Ectocarpus</i> spp., <i>Achnanthes</i> spp., show physiological tolerance to copper.	Voulvoulis 2002

### Shipboard Use

Generation	Electrically generated Cu ions	Rigby 2001
Storage	Solid form can be stowed "on deck" or "under deck", but clear of living quarters.	DOT 2002
Corrosivity	0.02-0.05 ppm can cause corrosion to aluminum.	Gracki 2002
Ventilation	Poison	DOT 2002

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
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Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>

West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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Gustavson, K, SA Wangberg. 1995.	Tolerance induction and succession in microalgae communities exposed to copper and atrazine	Aquatic Toxicology 32: 283-302
Haslbeck, JS, . 2003.	Measurement of copper release rates from antifouling paint under laboratory and in-situ conditions: implications for loading estimation to marine water	Marine Pollution Bulletin 46: 763-779
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Soldo, D, R Behra. 2000.	Long-term effects of copper on the structure of freshwater periphyton communities and their tolerance to copper, zinc, nickel, and silver	Aquatic Toxicology 47: 181-189
Voulvoulis, N, MD Scrimshaw, JN Lester. 2002.	Comparative environmental assessment of biocides used in antifouling paints	Chemosphere 47: 789-795

## Copper Sulfate

CuSO<sub>4</sub> • 5H<sub>2</sub>O

CAS\_# 7758-99-8

Available as a wettable powder or in liquid concentrate form.

**Other Names** Blue copper AS; Blue vitriol; Bluestone; copper sulfate (pentahydrate), copper sulphate pentahydrate; Copper(II)sulfate; Cupric Sulfate

**Trade\_Names** Blue Vitriol

Physiochemical Properties	Value or Comment	Citation
Physical State	grayish white greenish white rhombic crystals	Hazardous Substances Data Bank 2004
Specific gravity	3.6	Hazardous Substances Data Bank 2004
Solubility in water	243 g/l at 0 deg C; 75.4 g/100 cc water at 100 deg C	Hazardous Substances Data Bank 2004
Stability	Aquatic fate highly dependent on pH, concentration of organic matter, iron and manganese oxide and hardness of water.	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
amphibians	highly toxic	PAN 2004
crustaceans	slightly toxic	PAN 2004
fish	moderately toxic	PAN 2004
molluscs	very highly toxic	PAN 2004
nematodes and flatworms	very highly toxic	PAN 2004
zooplankton	slightly toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	Soluble copper compounds sorb strongly to suspended particles.	Hazardous Substances Data Bank 2004
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### Shipboard Use

Storage	Keep tightly closed	Hazardous Substances Data Bank 2004
Handling	strong irritant; wear gloves, boots, and goggles.	Hazardous Substances Data Bank 2004

### Laws and Regulations

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

### Citations

DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> :-
Hazardous Substances Data Bank, , . 2004.	Copper Sulfate	National Library of Medicine Toxnet System : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-

# Cupric Ascorbate

CAS\_# 3333-33-3

**Other Names**

**Trade Names**

## Environmental Acceptability

## Shipboard Use

## Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>

NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/region-112.rrr.html">http://sedac.ciesin.org/entri/register/region-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

#### Citations

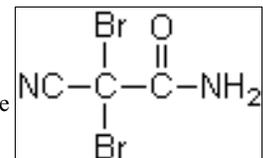
Sagripanti, J, A Bonifacino. 1996. Comparative Sporicidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551
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## Dibromonitripropionamide (DBNPA)

C<sub>3</sub>H<sub>2</sub>Br<sub>2</sub>N<sub>2</sub>O

CAS\_# 10222-01-2

Algicide, bactericide, fungicide, and preservative used in paper industry and water treatment. Available as a slow-release solid or as a liquid solution.



**Other Names** 2,2-dibromo-3-nitripropionamide; 2,2-Dibromo -2-carbamoylacetonitrile; 2,2-dibromo-3-nitripropionamide, DBNPA; dibromocynoacetamide

**Trade Names** Acetamide; Slimicide 508; XD-1603, XD-7287L Antimicrobial

Physiochemical Properties	Value or Comment	Citation
Physical State	liquid or solid	AMSA, Inc 2004
pH	6.61 in 0.01% aqueous solution at 25 deg C	Hazardous Substances Data Bank 2004
Solubility in water	15,000 mg/l.; log Kow= 0.80 @ pH 7; 0.795 @ pH 5; 0.82 @ pH 9.0	Hazardous Substances Data Bank 2004
Stability	quickly degrades to ammonia and bromide ion	AMSA, Inc 2004
Stability	Stable under normal conditions, decomposition accelerated by light & heat.	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
crustaceans	LC50: moderately toxic	PAN 2004
fish	LC50: moderately toxic	PAN 2004
molluscs	EC50: intoxication	PAN 2004
zooplankton	LC50: highly toxic	PAN 2004

### Environmental Acceptability

Byproducts	ammonia and bromide ion	AMSA, Inc 2004
Byproducts	When heated to decomposition it emits very toxic fumes of bromine & nitrogen oxides.	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	non-explosive, non-combustible; incompatible with bases, reducing substances & nucleophiles	Hazardous Substances Data Bank 2004
Corrosivity	liquid is an oxidizer because of hypobromous acid in formulation	AMSA, Inc 2004
Corrosivity	Corrosive to mild steel, iron and aluminum	Hazardous Substances Data Bank 2004

### Laws and Regulations

#### Citations

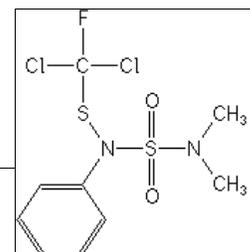
AMSA, Inc, , . 2004.	DBNPA Overview	<a href="http://www.amsainc.com/prod-dbnpa-overview.asp">http://www.amsainc.com/prod-dbnpa-overview.asp</a> : -
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PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -

## Dichlofluanid

C<sub>9</sub>H<sub>11</sub>Cl<sub>2</sub>FN<sub>2</sub>O<sub>2</sub>S<sub>2</sub>

CAS\_# 1085-98-9

Fungicide. Available in liquid form.



**Other Names** 1,1-dichloro-N-[(dimethylamino)sulfonyl]-1-fluoro-N-phenylmethanesulfenamide; N-dichlorofluoromethylthio-N',N'-dimethyl-N-phenylsulfamide; Aniline; dichlofluanid , N,N-Dimethyl-N'-phenyl-N'-((fluorodichloromethyl)thio)sulfamide; N-(Dichlorofluoromethylthio)-N',N'-dimethyl-N-phenylsulfamide; Sulfamide; N-((dichlorofluoromethyl)thio)-N',N'-dimethyl-N-phenyl-

**Trade\_Names** Bay 47531; Bay KUE 13032C; Dichlofluanid (France) , Diclofluanida; Diklofluanid; Elvaron; Euparen; Euparene; KUE 13032C

Physiochemical Properties	Value or Comment	Citation
Solubility in water	1.3 mg/L in water	Hazardous Substances Data Bank 2004
Stability	degrades faster at higher pH (pH=9); in alkaline medium, DT50 at 22 deg C >15 days at pH =4; in alkaline medium, DT50 at 22 deg C >18 hours at pH =7 and <10 minutes at pH of 9	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
crustaceans	EC50: behavior, mortality	PAN 2004
fish	EC50: mortality	PAN 2004
fungi	not provided	Hazardous Substances Data Bank 2004
molluscs	EC50: growth, mortality	PAN 2004
molluscs	LC50: moderately toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	may adsorb to suspended solids and sediment in water, Koc of 1100	Hazardous Substances Data Bank 2004
Environmental Acceptability	anaerobic half life <0.5 days. An increase half life of 1.4 days when is introduced as an antifouling paint.	Thomas 2003
Byproducts	in alkaline solution: N',N'-dimethyl-N-phenylsulphamide	Hazardous Substances Data Bank 2004
Byproducts	degrades will transform to N,N-dimethyl-N'-phenyl-Sulfamide (DMSA) with m-dichlorofluoromethylthion-aniline, aniline, and dichlorofluoromethane also being formed.	Thomas 2003
Inhibitors	adsorption to suspended solids and pH	Hazardous Substances Data Bank 2004
Effectiveness Factor	alkaline conditions	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	stable in storage for at least one year when worked up with small quantity of inert material; practically nonvolatile	Hazardous Substances Data Bank 2004
Handling	avoid contact with eyes and skin and inhalation.	Hazardous Substances Data Bank 2004

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/ne-pape.html">http://www.unep.ch/seas/main/nep/ne-pape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecc.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecc.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the	<a href="http://www.unepmap.gr/pdf/dumping">http://www.unepmap.gr/pdf/dumping</a>

	Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	.pdf
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/register-112.rrr.html">http://sedac.ciesin.org/entri/register/register-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

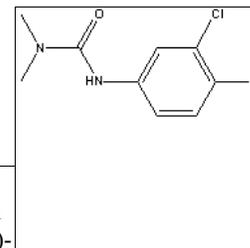
### Citations

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Hazardous Substances Data Bank, , . 2004.	Dichlofluanid	National Library of Medicine Toxnet System : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Thomas, KV, M McHugh, M Hilton, M Waldo. 2003.	Increased persistence of antifouling paint biocides when associated with paint particles	Environmental Pollution 123: 153-161

## Diuron

$C_6H_3Cl_2NHCON(CH_3)_2$  CAS\_# 330-54-1

Herbicide. Available as a solid (white, odorless, crystalline) or a liquid solution.



**Other Names** 1,1-Dimethyl-3-(3,4-Dichlorophenyl)urea; 1-(3,4-Dichlorophenyl)-3,3-dimethylurea; 3-(3,4-Dichlorophenyl)-1,1-Dimethylurea; M Velpar; Aguron; Diater; Di-on; Diurex; Diuron; Diuron ; Diuron 4L; Diuron 80; Cekiuron; Crisuron; Dailon; DCMU; DMU; Drexel diuron 4L; N'-(3,4-Dichlorophenyl)-N,N-Dimethylurea;

**Trade Names** Direx 4L; Direx 80W; Dynex; Karmex; Karmex 80W; Karmex DL; Unidron; Urox D; Vonduron; Xarmex, Krovar

Physiochemical Properties	Value or Comment	Citation
Solubility in water	n water, 36.4 mg/l @ 25 deg C	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
algae	reduced by 92% filamentous algae or common macrophytes (Potamogeton foliosus, Potamogeton pusillus, Najas flexilis, Najas gracillima, Ceratophyllum demorsum) during a study on twenty 3.048 m diameter pools. All the pools were stocked with fingerling bluegills (Lepomis macrochirus) and golden shiner (Notemigonus crysoleucas), which the diuron did not influence	Hazardous Substances Data Bank 2004
amphibians	LC50: slightly toxic	PAN 2004
ASELLUS	LC50 15.5 MG/L/96 HR (95% CONFIDENCE LIMIT 7.2-33.4 MG/L), @ 15 DEG C, MATURE /95% TECHNICAL GRADE/. STATIC BIOASSAY	Hazardous Substances Data Bank 2004
Bluegill	LC50 7.4 ppm/48 hr /Conditions of bioassay not specified	Hazardous Substances Data Bank 2004
carp	highly toxic	Hazardous Substances Data Bank 2004
crustaceans	LC50: slightly toxic	PAN 2004
Daphnia magna population	A concentration of 0.2 ppm diuron was lethal	Hazardous Substances Data Bank 2004
fish	LC50: slightly toxic	PAN 2004
molluscs	LC50: moderately toxic	PAN 2004
Oncorhynchus kisutch (fish)	LC50 16 mg/l/48 hr /Conditions of bioassay not specified	Hazardous Substances Data Bank 2004
phytoplankton	LC50: very highly toxic	PAN 2004
Rainbow trout	LC50 4.3 ppm/48 hr /Conditions of bioassay not specified	Hazardous Substances Data Bank 2004
zooplankton	LC50: slightly toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	expected to adsorb to suspended solids and sediment based upon the range of Koc values 224-879; Diuron is 67-99% degraded in 10 weeks under aerobic conditions by mixed cultures isolated from pond water and sediment.	Hazardous Substances Data Bank 2004
Environmental Acceptability	anaerobic half life of diuron: 14 days and CPD of 35 days	Thomas 2003
Byproducts	major product was 3,4-dichloroaniline(12). 3-(3,4-Dichlorophenyl)-1-methylurea and 3-(3,4-dichlorophenyl)urea (CPDU) were also identified	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	Avoid freezing liquid suspension. Dry formulations are stable under normal storage	Hazardous Substances Data Bank 2004
Handling	Contact with diuron (particularly in concentrated form) may irritate the eyes, nose, throat, and skin. Exposure to diuron may even prove fatal if sufficient quantities are inhaled, swallowed, or absorbed through the skin	Hazardous Substances Data Bank 2004

## Laws and Regulations

### Citations

Hazardous Substances Data Bank, , . 2004.	Diuron	National Library of Medicine Toxnet System : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Thomas, KV, M McHugh, M Hilton, M Waldoock. 2003.	Increased persistence of antifouling paint biocides when associated with paint particles	Environmental Pollution 123: 153-161
Thomas, KV, TW Fileman, JW Readman, MJ Waldoock. 2001.	Antifouling Paint Booster Biocides in the UK Coastal Environment and Potential Risks of Biological Effect	Marine Pollution Bulletin 42: 677-688

## Dowicil 75



CAS\_# 4080-31-3

designed to provide reliable and effective antimicrobial protection in a wide range of water-based products and formulations

**Other Names** 1-(3-chloroallyl)-3,5,7-triaza-1-azonia; 3,5,7-triaza-1-azoniaadamantane, 1-(3-chloroallyl)-, chloride; 1 - (3 - Chloroallyl) - 3,5,7 - triaza - 1 - azoniaadamantane chlorid

**Trade\_Names** Dowco 184, Dovicide Q, Dowicil 100, Dowicil 75; Quaternium 15

Physiochemical Properties	Value or Comment	Citation
Physical State	white to cream color powder	Hazardous Substances Data Bank 2004
pH	hydrolysis rate increases with increasing pH	Hazardous Substances Data Bank 2004
pH	acidic degrades rapidly; neutral to alkaline degrades slowly	U.S. EPA 1995
Density	0.4 g/cu cm	Hazardous Substances Data Bank 2004
Solubility in water	127.2 g/100 g water	Hazardous Substances Data Bank 2004
Stability	rapid degradation; half life is 1.5 days and 95-100% degradation after 7 days	Hazardous Substances Data Bank 2004
Stability	dissipates by abiotic hydrolysis; not persistent	U.S. EPA 1995

Target Organism	Treatment Dosage	Citation
crustaceans	LC50: not acutely toxic	PAN 2004
fish	LC50: slightly toxic	PAN 2004
fish and aquatic invertebrates	slightly toxic.	U.S. EPA 1995
molluscs	EC50: intoxication	PAN 2004
zooplankton	EC50: intoxication, mortality, reproduction	PAN 2004

### Environmental Acceptability

Environmental Acceptability	expected to adsorb to suspended solids and sediment based on Koc of 600. Log Kow of -0.10.	Hazardous Substances Data Bank 2004
Byproducts	decomposes to formaldehyde in aqueous solution	U.S. EPA 1995
Effectiveness Factor	degrades rapidly under acidic conditions. Under neutral to alkaline conditions, it degrades more slowly.	U.S. EPA 1995

### Shipboard Use

Storage	stable under ambient conditions	Hazardous Substances Data Bank 2004
Handling	skin irritant use chemical resistant gloves at a minimum	Hazardous Substances Data Bank 2004
Handling	causes moderate acute dermal toxicity so workers should wear gloves.	U.S. EPA 1995

### Laws and Regulations

#### Citations

Hazardous Substances Data Bank, , . 2004.	N-(3-CHLOROALLYL)HEXAMINIUM CHLORIDE	National Library of Medicine Toxnet System : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org">http://www.pesticideinfo.org</a> / : -
U.S. EPA, , . 1995.	R.E. D FACTS Dowicil CTAC	EPA-738-F-95-016 : 1-5

## Ethylene Oxide



CAS\_# 75-21-8

Available as colorless, liquified gas and used as a sterilant and fumigant.



**Other Names** Dihydrooxirene; dimethylene oxide; Epoxyethane; 1,2-Epoxyethane; Oxacyclopropane; Oxidoethane

**Trade Names** Ethene oxide; ETO; Oxirene; T-Gas; Oxiran; Oxyfume; Oxirane

Physiochemical Properties	Value or Comment	Citation
Physical State	colorless gas or liquid	Dow Chemical Company 1999
Physical State	colorless gas	Hazardous Substances Data Bank 2004
pH	acidic conditions have positive effect on hydrolysis rate.	Dow Chemical Company 1999
Density	0.882 at 10 deg C	Hazardous Substances Data Bank 2004
Specific gravity	0.875	Dow Chemical Company 1999
Solubility in water	miscible	Dow Chemical Company 1999
Solubility in water	miscible in all proportions with water	Hazardous Substances Data Bank 2004
Stability	not persistent in the environment degrades by biochemical oxidation, reactivity, volatilization, and dilution. Does not readily adsorb onto sediments. Half life of 9 days in 3% salt water	Dow Chemical Company 1999
Stability	half-life if 1 hour to 3.8 days depending on water body. Degrade due to hydrolysis.	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
brine shrimp	24-h LC50 = 350, 570, >500 mg/L; 48-h LC50 = 490, >500, 1000 mg/L (static, salt water)	Dow Chemical Company 1999
Daphnia magna	24-h LC50 = 260, 270, >300 mg/L; 48-h LC50 = 137, 200, 300 mg/L (static, fresh water)	Dow Chemical Company 1999
fathead minnow	maximum safe concentration = 41 mg/L; 96-h LC 50 = 86, 90, 274 mg/L; 48-h LC50 = 89 mg/L; 96-h LC50 = 84 mg/L (static and fresh water)	Dow Chemical Company 1999
goldfish	24-h LC50 = 90 mg/L (static, freshwater)	Dow Chemical Company 1999

### Environmental Acceptability

Environmental Acceptability	Ethylene glycol degraded rapidly.	Dow Chemical Company 1999
Environmental Acceptability	primarily lost by volatilization, hydrolysis, and biodegradation. Not tend to adsorb to sediments - low Kow (log Kow of -0.3), Koc of 16	Hazardous Substances Data Bank 2004
Byproducts	ethylene glycol due to hydrolysis	Dow Chemical Company 1999
Byproducts	ethylene glycol and ethylene chlorohydrin	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	Depends on formulation.	DOT 2002
Storage	Store at ambient conditions. fire or explosion, may be ignited by heat, sparks, flame. Stable in water.	Hazardous Substances Data Bank 2004
Handling	irritating to eyes, respiratory tract, and skin. Wear chemical protective clothing, goggles, wear SCBA	Hazardous Substances Data Bank 2004

## Laws and Regulations

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

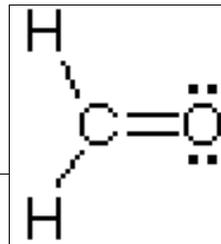
## Citations

DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> : -
Dow Chemical Company, , Shell Chemical Co., Equistar Chemicals, Sunoco. 1999.	Ethylen Oxide Users Guide	Second Edition : -
Hazardous Substances Data Bank, , . 2004.	Ethylene Oxide	National Library of Medicine Toxnet System : -

## Formaldehyde



CAS\_# 50-00-0



Formaldehyde is a colorless gas with a strong odor which is usually mixed in a water and Methanol solution. It is used as a bactericide, fungicide, an intermediate in chemical and resin manufacturing, in pressed-wood products, and in textile finishing. Also available as a colorless liquid.

**Other Names** Methanal; Methylene oxide; Formalin

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	colorless liquid	Hazardous Substances Data Bank 2004
pH	2.8 - 4.0	Hazardous Substances Data Bank 2004
pH	Ineffective throughout pH range on bacterial spores at 8% concentration	Sagripanti 1996
Density	1.067	Hazardous Substances Data Bank 2004
Specific gravity	0.816	Hazardous Substances Data Bank 2004
Solubility in water	400000 mg/L at 20 deg C	Hazardous Substances Data Bank 2004
Stability	degradation complete in 48 hours under anaerobic conditions	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
Bacillus subtilus spores	8% resulted in < 90% inactivation (ineffective)	Sagripanti 1996
Bacillus subtilus spores	8% for 30 min at 20 deg C is ineffective (< 90% inactivation)	Bacillus subtilus spores 1996

**Environmental Acceptability**

Environmental Acceptability	Koc of 37, not expected to adsorb to suspended solids and sediments. Log Kow = 0.35	Hazardous Substances Data Bank 2004
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**Shipboard Use**

Storage	Material may be stowed on deck or under deck on a cargo vessel and on a passenger vessel. If 25% or more formaldehyde in solution, material should be stowed clear of living quarters.	DOT 2002
Storage	Protect against physical damage. Separate from oxidizing and alkaline material. Flammable.	Hazardous Substances Data Bank 2004
Handling	contact with skin causes irritation, tanning effect, and allergic sensitization. Formaldehyde vapor is very irritating to mucous membranes and toxic to man.	Hazardous Substances Data Bank 2004
Corrosivity	Corrosive hazard class when solution is not less than 25% formaldehyde. All solutions should be labeled as corrosive and flammable.	DOT 2002
Corrosivity	aqueous formaldehyde is corrosive to carbon steel, but vapor phase is not.	Hazardous Substances Data Bank 2004
Ventilation	Corrosive and flammable.	DOT 2002

**Laws and Regulations**

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Canada	Canada Shipping Act - Part (XV): Pollutant Substances Regulations (CRC, c. 1458)	<a href="http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html">http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	

East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/eg-112.rrr.html">http://sedac.ciesin.org/entri/register/eg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

### Citations

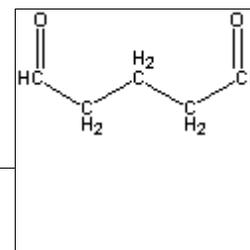
DOT, . . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> : -
Hazardous Substances Data Bank, . . 2004.	Formaldehyde	National Library of Medicine Toxnet System : -
Sagripanti, J, A Bonifacino. 1996.	Comparative Sporicidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551

## Glutaraldehyde



**CAS\_#** 111-30-8

A strong sporicide, generally unaffected by organic material, non-corrosive. Used in hospitals and laboratories as a disinfectant and in tanning as a biological fixative. Available as a colorless liquid.



**Other Names** 1,5-Pentanedial; Glutaral; Glutardialdehyde; Glutaric dialdehyde; Aqucar 545

**Trade Names** Cidex; Cidex Long-life; Microcide; Nalco 7338; Neoquat LA; Safeguard; Sepacid GA 50; Sonacide; Ucarcide 125; Ucarcide 225; Ucarcide 250; Uconex 350

Physiochemical Properties	Value or Comment	Citation
pH	Rate of reaction is pH dependent, increasing over range of 4-9	Hopwood 1970
pH	Mildly acidic. Usually supplied in range of 3-6.	Lubomudrov 1997
pH	More effective at higher pH	Oemcke 1999
Density	1.13 (50%), 0.72 (100%)	Lubomudrov 1997
Specific gravity	1.129	Lubomudrov 1997
Solubility in water	100%	Lubomudrov 1997
Stability	Affected by pH	Lubomudrov 1997
Inactivation	Only aldehyde to exhibit excellent sporicidal activity.	Scott 1991
Inactivation	0.02% solution is rapidly effective against gram-positive and gram-negative species; 2 % solution is capable of killing vegetative species including <i>S. aureus</i> , <i>P. vulgaris</i> , <i>E. coli</i> , and <i>P. aeruginosa</i> within 2 minutes.	Stonehill 1963

Target Organism	Treatment Dosage	Citation
Algae	Dose depends on target organism and volume of ballast water.	Lubomudrov 1997
Bacillus anthracis	4-log inactivation in 15-30 minutes using ????. Concentration	Rubbo 1967
Bacillus spp	2% solution inactivated spores in 3 hours	Stonehill 1963
Bacillus subtilus spores	30 min*mg/L	Sagripanti 1996
Bacteria	Dose depends on target organism and volume of ballast water.	Lubomudrov 1997
Bacterial spores	20,000 mg/L	Oemcke 1999
Bacterial spores	20,000 mg/L	Oemcke 1999
Clostridium spp	2% solution inactivated spores in 3 hours	Stonehill 1963
Clostridium tetani	4-log inactivation in 15-30 minutes using ????. Concentration	Rubbo 1967
Daphnia magna	50% solution for 48 hours LC50 = 11.5 ppm, LC100 = 23 ppm.	Lubomudrov 1997
E. Coli	100 ug/mL alkaline glutaraldehyde completely inactivates $2 \times 10^8$ cells/mL in 10 minutes compared to 45% inactivation with solution	McGucken 1973
Feline Calicivirus (FCV)	Final concentration of 0-5 % Glutaraldehyde give a Log10 reduction of 5	Doultree 1999
fish	LC50: slightly toxic	PAN 2004
Fungi	Sonacide (an acid-based glutaraldehyde formulation) was effective against <i>A. niger</i> and <i>A. fumigatus</i> . Sporicidin (a glutaraldehyde-phenate mixture) was NOT effective even after 90 minutes. 0.5% alkaline glutaraldehyde inhibits mycelial growth and sporulation and spore swelling is entirely halted.	Scott 1991
fungi	EC50: population	PAN 2004
Grass shrimp	100% solution for 96 hours LC50 = 41 ppm, LC100 = 82 ppm.	Lubomudrov 1997
molluscs	EC50: intoxication	PAN 2004
Poliovirus	500 mg/L	Oemcke 1999
Rainbow trout	50% solution for 96 hours LC50= 23.7 ppm, LC100 = 47.4 ppm.	Lubomudrov 1997
Viruses	500 mg/L for poliovirus	Oemcke 1999
Viruses	Dose depends on target organism and volume of ballast water.	Lubomudrov 1997
zooplankton	LC50: slightly toxic	PAN 2004

## Environmental Acceptability

Environmental Acceptability	concentration released into environment depends on initial concentration. Levels <5ppm are considered to be nonbiocidal. Concentrations <1ppm are classified as "readily" biodegradable. Once released into the environment, it will remain in aqueous solution. Under aerobic conditions, glutaraldehyde decomposes to carbon dioxide. Under anaerobic conditions, glutaraldehyde decomposes to 5-hydroxypentanal which is further metabolized to 1,5-pentenediol.	Lubomudrov 1997
Byproducts	Reaction products with amino acids	Kirkeby 1987
Byproducts	Reacts with protein to form unsaturated polymer	Monsan 1975
Inhibitors	Generally unaffected by organic material. Low pH reduces effectiveness. Efficacy improves as temperature increases.	Oemcke 1999
Effectiveness Factor	Mixing into ballast tank residuals likely to be difficult. 20,000 mg/L doses will be expensive.	Oemcke 1999

## Shipboard Use

Storage	Store in cool area (<room temperature, ideally 25-37 degrees C). Storage at elevated temperatures may shorten shelf-life.	Lubomudrov 1997
Size	Small pumps that meter the chemical into ballast water. Systems could be installed into existing vessels in addition to being integrated into new vessel design.	Lubomudrov 1997
Corrosivity	Will not permanently damage ballast piping or tank systems, nor adversely affect protective coatings on pipes when in solution.	Lubomudrov 1997
Corrosivity	Non-corrosive	Oemcke 1999
Limits	Mixing chemical in tank difficult and doses of 20,000 mg/L are expensive.	Oemcke 1999

## Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
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United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>

USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

### Citations

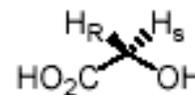
Doultree, JC, Druce, J. D., Birch, C. J., Bowsden, D. S., and J. A. Marshall. 1999.	Inactivation of feline calicivirus, a Norwalk virus surrogate	The Hospital Inspection Society : -
Hopwood, D, Allen, C.R., and C. McCabe. 1970.	The reaction between glutaraldehyde and various proteins: an investigation of their kinetics	Histochem J 2: 137-150
Kirkeby, S, Jacobsen, P., and D. Moe. 1987.	Glutaraldehyde pure and impure. A spectroscopic investigation of two commercial glutaraldehyde solutions and	Anal. Lett 20: 303-315
Lubomudrov, L, R Moll, M Parsons. 1997.	An Evaluation of the Feasibility and Efficacy of Biocide Application in Controlling the Release of Nonindigenous Aquatic Species from Ballast Water	Report to MI DEQ, Office of the Great Lakes : -
McGucken, PA, W. Woodside. 1973.	Studies on the mode of action of glutaraldehyde on Escherichia Coli	J. Appl. Bacteriol 36: 419-
Monsan, P, Puzo, G., and H. Mazarguil. 1975.	Étude du mécanisme d' établissement des liaisons glutar-aldéhydeprotéines	Biochimica 57: 1281-
Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Rubbo, SD, Gardner, J.F., and R.L. Webb. 1967.	Biocidal activities of glutaraldehyde and related compounds	. Appl. Bacteriol 30: 78-
Sagripanti, J, A Bonifacino. 1996.	Comparative Sporicidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551
Scott, E, S Gorman. 1991.	Glutaraldehyde. In: Disinfection, Sterilization, and Preservation	S.S. Block (Ed) Lea & Feviger, Philadelphia : -
Stonehill, AA, Krop, S., and P.M. Borick. 1963.	Buffered glutaraldehyde, a new chemical sterilizing solution	Am. J. Hosp. Pharm 20: 458-

## Glycolic Acid



CAS\_# 79-14-1

Moist white crystalline powder

**Other Names** Acetic acid; hydroxy-;**Trade\_Names**

### Environmental Acceptability

### Shipboard Use

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kwait.marine.pollution.1978.html</a>

NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

#### Citations

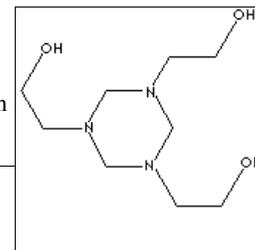
Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
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## Grotan



CAS\_# 4719-04-4

Alkaline, clear to light yellow viscous liquid used in formulating bactericide and fungicide. It is used as a preservative in oil field applications



**Other Names** hexahydro-1,2,5-tris(2-hydroxyethyl)-s-triazine; Hexahydro- 1,3 ,5-tris(2-hydroxyethyl)-s-triazine; 1,3,5-triazine-1,3,5-(2H, 4H, 6H)-triethanol; Triazinetriethanol; Tris(2-hydroxyethyl)hexahydro-s-triazine;

**Trade\_Names** Grotan; Triadine 3; Onyxide 200 MUP

Physiochemical Properties	Value or Comment	Citation
Physical State	clear viscous liquid	GR OShea Company 2004
pH	10.3 - 11.3 at 25 deg C	GR OShea Company 2004
Specific gravity	1.152	GR OShea Company 2004
Viscosity	250 cps	GR OShea Company 2004
Solubility in water	miscible with water in all proportions	GR OShea Company 2004
Stability	normal shelf life is a minimum of 2 years	GR OShea Company 2004

### Environmental Acceptability

### Shipboard Use

Storage	Store in original container for ~2 years when stored between -10 deg C and 40 deg C	GR OShea Company 2004
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### Laws and Regulations

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

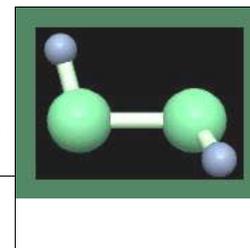
### Citations

GR OShea Company, , . 2004.	Grotan	<a href="http://www.groshea.com/troy/grotan.html">http://www.groshea.com/troy/grotan.html</a> : -
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# Hydrogen Peroxide



CAS\_# 7722-84-1



Hydrogen peroxide solutions of 10-25% are used to purify drinking water; treat contaminated water supplies; sterilize spacecraft and disinfect contact lenses. Hydrogen peroxide solutions of 15-35% are used to sterilize the contact surfaces of food packaging. Available as a colorless, syrupy liquid or as a crystalline solid (below 12 deg. F).

**Other Names** dioxogen; Dihydrogen dioxide; Genoxide+so; Hioxyl; Hydrogen dioxide; hydroperoxide; hydrozone; Lensan A; Mirasept; Oxysept; Oxzone; Pegasyl; Percarbamid; Perhydrol; Peroxal; Peroxol; Peroxyl; Proxy; Truzone

**Trade Names** Albone; Kastone; Perone; Tysu; Interox

Physiochemical Properties	Value or Comment	Citation
Physical State	colorless liquid	Hazardous Substances Data Bank 2004
pH	Ineffective throughout pH range	Sagripanti 1996
Density	1.4425 at 25 deg C	Hazardous Substances Data Bank 2004
Solubility in water	miscible with water; In water 1000000 mg/L at 25 deg C.	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
Bacillus subtilus spores	10% is ineffective (<90% inactivation) at room temperature for 30 min	Sagripanti 1996
Crustaceans	from EC50: behaviro, biochemistry, development, intoxication, mortality	PAN 2004
Daphnia magna	Minimum concentration of 18,000 ppm, maximum concentration of 32,000 ppm, and a mean concentratoin of 24,000 ppm will result in the immobility of the species less than 24 hours.	PAN 2004
Daphnia magna	Minimum concentration of 18,000 ppm, maximum concentration of 32,000 ppm, and a mean concentratoin of 24,000 ppm will result in the immobility of the species less than 24 hours.	Pesticide Ecotoxicity Database 2000
Dreissena polymorpha	minimum concentration of 29,300 ug/L, maximum concentration of 298,000 ug/L and a mean concentration of 29,600 ug/L will result in mortality in 3.5 hours.	Matisoff 1996
Fish	EC50: behavior, biochem, feeding behavior, growth, mortality	PAN 2004
Fish	LC50: not acutely toxic	PAN 2004
Fungi	EC50: population	PAN 2004
Molluscs	behavior, mortality, reproduction	PAN 2004
Oscillatoria rubescens	1,750 ug/L will cause mortality in less than 1 day	Barroin 1986
Phytoplankton	EC50: biochem, histology, mortality, physiology, population	PAN 2004
Saprolegnia sp.	100,000 ug/L is toxic to the population	Marking 1994
Zooplankton	EC50: behavior, intoxication, mortality	PAN 2004

## Environmental Acceptability

## Shipboard Use

Application	Product: \$0.34 per lb-50% (FOB Houston, TX); Freight: \$3.50 per mile (regardless of delivery volume)	U.S. Peroxide 2004
Storage	Must be stowed "on deck only" on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers or one passenger per each 3 m of overall vessel length, but the material is prohibited on passenger vessels in which the limiting number of passengers is exceeded. Shade material from radiant heat. Stow separated from flammable solids, permanganates, and powdered metal.	DOT 2002
Storage	Storage tanks should be constructed of high-purity aluminium; keep away from direct heat and sun and combustible materials. Do not touch damaged containers or spilled material unless wearing appropriate protective clothing.	Hazardous Substances Data Bank 2004
Handling	Oxidizer hazard class	DOT 2002
Handling	Inhalation, ingestion, or contact (skin, eye) with vapors or substance may cause severe injury, burns, or death; protective chlothing: Wear positive pressure self-contained breathing apparatus (SCBA)	Hazardous Substances Data Bank 2004
Corrosivity	hydrogen peroxide destroys residual chlorine and reduced sulfur compounds thiosulfates, sulfites, and sulfides which form corrosive acids whtn condensed onto processing equipment and oxidized	U.S. Peroxide 2004

Ventilation	by air proper ventilation required	Hazardous Substances Data Bank 2004
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### Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	CERCLA section 103, codified at 40 CFR part 302, in addition to requirements of 40 CFR part 355	
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>

Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>
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Hazardous Substances Data Bank, , . 2004.	Hydrogen peroxide	National Library of Medicine Toxnet System : -
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PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Sagripanti, J, A Bonifacino. 1996.	Comparative Sporocidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551
U.S. Peroxide, , . 2004.	Intro to H2O2	<a href="http://www.h2o2.com">www.h2o2.com</a> : -

# Iodine



CAS\_# 7553-56-2

Iodine is a bluish-black, lustrous solid used as a microbiocide, fungicide, or herbicide.



**Other Names** iodine crystals; molecular iodine

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Solubility in water	only slightly soluble in water; Solubility in water is increased by alkali bromides and decreased by sulfates and nitrates. Measurements: 0.034 g/kg in water @ 25 deg C; 0.029 g/100 cc in water @ 20 deg C; 0.078 g/100 cc in water @ 50 deg C; 330 mg/l in water at 25 deg C	Hazardous Substances Data Bank 2004
Inactivation	Iodine causes chemical action and cell/protein disruption	Letcher 2003

Target Organism	Treatment Dosage	Citation
Feline Calicivirus (FCV)	Final concentration of 0-8% give a Log10 reduction of 1-25	Doultree 1999
fish	moderately toxic	PAN 2004
fungi	no LC50 but population effects from EC50	PAN 2004
Waterborne microorganisms	Iodinated resins: most waterborne microorganisms susceptible to doses up to 5 mg/L as I <sub>2</sub>	Letcher 2003
zooplankton	highly toxic	PAN 2004

### Environmental Acceptability

Environmental Acceptability	Iodine at certain concentrations is toxic to certain fresh water and marine species. Acceptable levels for specific applications are not known.	Letcher 2003
Byproducts	Iodine: same as for bromine except resulting iodinated organics are typically much lower in concentration; reduced form of free iodine-- iodide ion, I <sup>-</sup>	Letcher 2003

### Shipboard Use

Handling	Iodine vapor is irritating to the eyes	Hazardous Substances Data Bank 2004
Corrosivity	Iodine is a powerful oxidizing agent	Hazardous Substances Data Bank 2004
Power Requirements	Needs research	Letcher 2003

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
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Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	

Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

### Citations

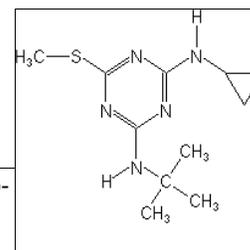
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Hazardous Substances Data Bank, , . 2004.	Iodine	National Library of Medicine Toxnet System : -
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PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -

## Irgarol 1051 (Cybutryne)

**C<sub>11</sub>H<sub>19</sub>N<sub>5</sub>S**

**CAS\_# 28159-98-0**

Microbiocide used for antifouling. Available as a white or slightly yellow powder.



**Other Names** 1,3,5-Triazine-2,4-diamine; N-cyclopropyl-N'-(1,1-dimethylethyl)-6-(methylthio)-; 2-(tert-Butylamino)-4-(cyclopropylamino)-6-(methylthio)-1,3,5-triazine; 2-(tert-butylamino)-4-cyclopropylamino-6-methylthio-1,3,5-triazine; Cyclopropyl-n'(1,1-dimethylethyl)-6-(methylthio)1,3,5-triazine,2,4,di=; N-Cyclopropyl-N'-(1,1-dimethylethyl)-6-(methylthio)-1,3,5-triazine-2,4-diamine; s-Triazine; 2-(tert-butylamino)-4-(cyclopropylamino)-6-(methylthio)-

**Trade\_Names** Irgarol 1051; Irgarol 1071

Physiochemical Properties	Value or Comment	Citation
Physical State	crystalline powder	Ciba Specialty Chemicals, Inc. 1999
Solubility in water	7 mg/L; Kow = 3.95; Koc = 3100 L/kg (dissolved phase), 1240 L/kg (suspended phase)	Albanis 2002
Solubility in water	Water solubility dependent on salinity values at 25 deg C and pH of 7: 0.0 Mol NaCl/L = 9mg/L; 0.3 Mon NaCl/L = 5.9 mg/L; 0.6 Mol NaCl/L = 1.8 mg/L	Ciba Specialty Chemicals, Inc. 1999
Inactivation	blocks pivotal step of electron transport	Ciba Specialty Chemicals, Inc. 1999

Target Organism	Treatment Dosage	Citation
Algae	Concentration between <1 and 1700 ng/l. Safety level of 0.4 ug/L for algae, 1.6 ug/L for other aquatic organisms.	Thomas 2001
Anthocidaris crassispina	At higher concentration of 10 mg/L, the eggs were mostly unfertilized and later showed induced cytolysis. Retarded cleavage and development were evident at 1 mg/L. The concentration of 0.01-0.1 mg/L induced cytolysis and allowed a normal state.	Kobayashi 2002
aquatic plants	EC50: accumulation, growth, physiology, population	PAN 2004
Crustacean, A. salina	For a concentration level of 40 mg/L, Irgarol caused 30% mortality of the organisms	Okamura 2000
cyanobacteria (Anabaena flos-aquae)	2 ug/L	Ciba Specialty Chemicals, Inc. 1999
D. magna	The toxicity of Irgarol 1051 was by a 48 h-EC50 value of 8.1 mg/L and a LC50 value of 0.86 mg/L.	Okamura 2000
Daphnia	LC0 is 440 ug/L	Ciba Specialty Chemicals, Inc. 1999
diatoms	0.1 to 0.4 ug/L	Ciba Specialty Chemicals, Inc. 1999
Enteromorpha intestinalis	An EC50 value of 5.4 ug/L inhibited the growth.	Okamura 2000
fish	LC50: moderately toxic	PAN 2004
green algae (Raphidocelis subcapitata)	1 ug/L	Ciba Specialty Chemicals, Inc. 1999
Hemicentrotus pulcherrimus	At higher concentration of 10 mg/L, the eggs were mostly unfertilized and later showed induced cytolysis. Retarded cleavage and development were evident at 1 mg/L. The concentration of 0.01-0.1 mg/L induced cytolysis and allowed a normal state.	Kobayashi 2002
higher plants (Lemna gibba)	2 ug/L	Ciba Specialty Chemicals, Inc. 1999
Lemna gibba	A 14-day EC50 value of 1.62 ug/L inhibited the growth.	Okamura 2000
molluscs	EC50: intoxication	PAN 2004
Mysid shrimps	LC0 is 130 ug/L	Ciba Specialty Chemicals, Inc. 1999
oyster larvae	LC50 over 48 hours was 3200 ug/L.	Ciba Specialty Chemicals, Inc. 1999
Periphyton community	At concentration levels of 63-250 ng/L in seawater, Irgarol was shown to be capable of damaging sensitive periphyton communities.	Okamura 2000
Periphyton community	Detection limit of 1-5 ng/L. Irgarol is toxic to microalgal communities of Enteromorpha intestinalis at 50 ng/L and long term effects on periphyton communities in coastal water were observable at ambient levels between 63 and 250 ng/L	Liu 1998
Periphyton community	Irgarol with concentration of 1 nM (approximately 250 ng/L) produced changes in the structure of the periphyton community.	Connelly 2001

phytoplankton	EC50: ecosystem process, physiology, population	PAN 2004
Rainbow Trout	The toxicity of Irgarol 1051 was by a 48 h-EC50 value of 8.1 mg/L and a LC50 value of 0.86 mg/L.	Okamura 2000
S. capricornutum	The phototoxicity of Irgarol has been reported as 1.26 ug/L (120 h-EC50) and 0.45 ug/L (120 h-EC50).	Okamura 2000
Sea organism	Cell density range from 0.136 ppb for Navicula pelliculosa (a freshwater diatom) to 2.07 for Anabaena flos-aquae (a freshwater blue algae). The value varies from 400 ppb for Misidopsis bahia to 5300 ppb for Daphnia magna.	Voulvoulis 2000
Skeletonema costatum	The phototoxicity of Irgarol has been reported as 1.26 ug/L (120 h-EC50) and 0.45 ug/L (120 h-EC50).	Okamura 2000
V. fisheri	For a concentration level up to 50 mg/L, had little effect on the organism.	Okamura 2000
zooplankton	LC50: moderately toxic	PAN 2004
Zostera marina	An Irgarol concentration of 0.18 ug/L can reduce the growth rate of the leaves. Where the concentration was found mainly in leaves than in roots.	Scarlett 1999

### Environmental Acceptability

Environmental Acceptability	half life of 25 days; does not bioaccumulate and is of low risk to animals like oysters, crustaceans, fish or birds at concentrations designed to inhibit target organisms (e.g., photosynthetic organisms). Koc: 3100 L/kg (dissolved phase, 1240 L/kg (suspended phase).	Ciba Specialty Chemicals, Inc. 1999
Environmental Acceptability	not readily degraded with half life of 100 days	Thomas 2000
Environmental Acceptability	anaerobic half life over 226 days	Thomas 2003
Byproducts	inactive metabolites	Ciba Specialty Chemicals, Inc. 1999
Byproducts	Chemical degradation of 1051 by mercuric chloride appeared to follow the reaction of a catalyzed hydrolysis and the mech apparently involved the formation of bidentate chelation, which weakened the cyclopropylamino bond and resulted in formation of a hydrolysis product M1. M1 is the major degradation product during the biological and chemical degradation of 1051.	Liu 1998
Byproducts	Biodegradation, photodegradation, and chemical hydrolysis of Irgarol 1051 as the result in n-dealkylation to yield 2-methylthio-4-tert-butylamino-6-amino-s-triazine (GS26575) as the principle of degradation product	Thomas 2000
Inhibitors	Half life: 100 or 200 days for marine or freshwater, respectively	Albanis 2002
Effectiveness Factor	As a herbicide, Irgarol 1051 is much more toxic to algae and higher plant species, mainly due to inhibition of photosynthesis.	Okamura 2000
Effectiveness Factor	When some flushing is allowed (in open tidal marinas, the runoff is quickly diluted and flushed out by the tide), 1051 concentration was found higher than non-flushing	Thomas 2001

### Shipboard Use

### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepe.html">http://www.unep.ch/seas/main/nep/nepe.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>

Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
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South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/register-112.rrr.html">http://sedac.ciesin.org/entri/register/register-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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Thomas, KV, M McHugh, M Hilton, M Waldock. 2003.	Increased persistence of antifouling paint biocides when associated with paint particles	Environmental Pollution 123: 153-161
Thomas, KV, SJ Blake, MJ Waldock. 2000.	Antifouling Paint Booster Biocide Contamination in UK Marine Sediment	Marine Pollution Bulletin 40: 739-745
Thomas, KV, TW Fileman, SV Evans, ME Donkin. 2001.	Antifouling paint booster biocides in the UK coastal environment and potential risks of biological effects	Marine Pollution Bulletin 42: 677-688
Tolosa, I, Readman, J. W., Blaevoet, A. Ghilini, S., Bartocci, J., and Horvat, M. 1996.	Contamination of Mediterranean (Cote d' Azur) Coastal Waters by Organotins and Irgarol 1051 Used in Antifouling Paints	Marine Pollution Bulletin PII: S0024-326X(96)00013-6. : -



## Mexel 432 (Fatty Amines)

CAS\_# 00-00-0

This mixture of aliphatic amine surfactants is an anti-fouling material that acts as a corrosion inhibitor and scale dispersant as well as having activity against freshwater and saltwater mussels and barnacles; commercial molluscicide using 1.7 % solution of (alkylamino)-3-aminopropane. Available as a slightly milky homogeneous liquid.

**Other Names** chemical name = (Alkylamino)-3-aminopropane

**Trade\_Names** Mexel 432/0

Physiochemical Properties	Value or Comment	Citation
pH	11	RTK Technologies, Inc 2004
Stability	Half life of 22 hours in river water; decreases to ~ 6 hours with aeration and agitation	RTK Technologies, Inc 2004
Inactivation	registered as a FIFRA molluscicide; effective in inhibiting toxic algae blooms and growth of bacteria colonies by retarding population growth by eliminating the habitat toxic to fish	RTK Technologies, Inc 2004

### Environmental Acceptability

Environmental Acceptability	contains no halogens, aromatics, quaternary amines, phosphorus, heavy metals, sulfur, cyclic hydrocarbons, zinc, or oxidizing agents	RTK Technologies, Inc 2004
Byproducts	only products of its biodegradation are carbon dioxide, water, and a trace of nitrogen	RTK Technologies, Inc 2004

### Shipboard Use

Application	0.033 lbs/day per 100 sq ft of surface per day (for controlling mollusks in closed delivery systems)	RTK Technologies, Inc 2004
Storage	Store the barrels hermetically closed far of bad weather and without intense heat source (<60 deg C). Avoid oxidizing agents (peroxides, perchlorates, nitrates, etc.) strong acid and halogen-organic compounds.	RTK Technologies, Inc 2004
Handling	non-flammable, low vapor pressure -- safe to use in confined spaces	RTK Technologies, Inc 2004
Corrosivity	Used as a corrosion inhibitor	RTK Technologies, Inc 2004
Ventilation	well ventilated area	RTK Technologies, Inc 2004

### Laws and Regulations

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Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>

	Incineration at Sea	
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
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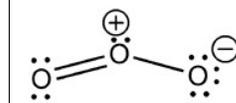
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# Ozone



CAS\_# 10028-15-6



Ozone is found in the atmosphere in varying proportions as it is produced continuously in the outer layers of the atmosphere by the action of solar UV radiation on the oxygen of the air. It is also formed locally in the air from lightning and electrical sparks. In freshwater, ozone is an excellent disinfectant and in seawater, ozone is used to control bacteria and viruses. Available as in gas form, in liquid form (below its boiling point of -112 deg. C), or in solid form (below its melting point of -193 deg. C)

**Other Names** Triatomic oxygen, trioxygen

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	gas	U.S. EPA 1999
pH	Ozone decomposes faster as pH increases but biocidal activity not influenced by pH	U.S. EPA 1999
Specific gravity	2.144	CCOHS 2004
Solubility in water	Slightly soluble (0.11 g/100 mL or 49.4% v/v at 0 deg C ; 0.06 g/100 mL at 20 deg C)	CCOHS 2004
Solubility in water	sparingly soluble	U.S. EPA 1999
Stability	Reacts with dissolved organics, iron(II), manganese(II), and sulphite very quickly.	Oemcke 1999
Stability	decays rapidly at high pH and warm temperatures	U.S. EPA 1999
Inactivation	Cell wall rupture (lysing)	Jackson 2003
Inactivation	Production of halogens and injection of ionized air	Stewart 2003
Inactivation	attacks bacterial membranes and disrupts enzymatic activity, and may also act on the nuclear material within cell. Virus inactivation is the virion capsid, particularly the proteins. RNA may also be the target	U.S. EPA 1999

Target Organism	Treatment Dosage	Citation
All microroganisms	1 mg/L	Jackson 2003
Cryptosporidium parvum	40 mg/L effective dose for drinking water	Biswas 2003
Cryptosporidium parvum oocysts	4-10 min*mg/L can achieve 2-log (99%) reduction	Oemcke 1999
Cryptosporidium parvum oocysts	1 ppm (1 mg/L) for 5 min achieved > 90% inactivation	Korich 1990
Enterococci	~2-log reduction: 30-50 mg/L	Gehr 2003
Entrococcus seriolicida	0.111 mg/L achieves 2-log (99%) reduction or 0.123 mg*min/L; 0.177 mg/L achieves 3-log (99.9%) reduction or 0.186 mg*min/L; 0.246 mg/L achieves 4-log reduction; 0.319 mg/L achieves 5-log reduction; 0.393 mg/L achieves 6-log reduction	Sugita 1992
Escherichia coli	0.6 ug/L dissolved ozone can achieve 4-log (99.99%) reduction in less than 1 minute with a residual of 9 ug/L at 12 degrees C.	U.S. EPA 1999
fish	LC50: highly toxic	PAN 2004
Giardia cysts	To achieve 0.5-log, 1.0-log, 1.5-log, 2.0-log, 2.5-log, 3.0-log inactivation: 0.23 mg-min/L, 0.48 mg-min/L, 0.72 mg-min/L, 0.95 mg-min/L, 1.2 mg-min/L, and 1.43 mg-min/L.	Cowley 1999
Giardia muris	Inactivation at pH 8 and 15 deg C shows dependency between log kill and the initial concentration of microorganisms. The level of inactivation decreases as initial organism concentration decreases.	Hass 2003
Giardia muris cysts	2 min*mg/L can achieve 2-log (99%) reduction	Oemcke 1999
Legionella pneumophila	0.21 mg/L ozone can achieve 2-log (99%) removal within 5 min	U.S. EPA 1999
molluscs	EC50: mortality	PAN 2004
MS-2	Less resistant than enterococci	Gehr 2003
Mycobacterium tuberculosis	0.21 mg/L ozone achieves 4-log (99.99%) reduction with >30 min contact time	U.S. EPA 1999
Pasteurella piscicida	2-log removal: 0.063 mg/L or 0.057 mg*min/L; 3-log removal: 0.089 mg/L or 0.084 mg*min/L; 4-log removal: 0.115 mg/L; 5-log removal: 0.140 mg/L; 6-log removal: 0.165 mg/L	Sugita 1992
Perfringens	More resistant than enterococci	Gehr 2003
Streptococcus faecalis	0.21 mg/L ozone achieves 2-log (99%) reduction with contact time of >10 min	U.S. EPA 1999
Vibrio anguillarum	2-log removal: 0.081 mg*min/L; 3-log removal: 0.123 mg*min/L	Sugita 1992
Viruses	To achieve 2-log, 3-log, 4-log inactivation: 0.5 mg-min/L, 0.8 mg-min/L, 1.0 mg-min/L,	Cowley 1999

respectively.

### Environmental Acceptability

Environmental Acceptability	Brominated organics and bromate can have negative environmental impacts at low concentrations.	Oemcke 1999
Byproducts	Oxygen, brominated organics; Brominated organics are naturally biodegradable	Jackson 2003
Byproducts	Brominated organics, bromate, and bromines	Oemcke 1999
Byproducts	organic acids and aldehydes. If bromide ion is present or chlorine added, halogenated DBPs may form	U.S. EPA 1999
Effectiveness Factor	Ozone is more effective in freshwater systems.	Oemcke 1999
Effectiveness Factor	As temperature increases, ozone becomes less soluble and less stable in water.	U.S. EPA 1999

### Shipboard Use

Generation	Ozone is generated on-site, at its point of use usually by dissociation of molecular oxygen electrically (silent discharge) or photochemically (ultraviolet irradiation).	CCOHS 2004
Generation	Ozone can be safely generated with on-site air.	Oemcke 1999
Generation	should be generated at the point of use. Feed gas should be clean and dry with max dewpoint of -60 deg C. Relatively complex process	U.S. EPA 1999
Storage	not easily stored	CCOHS 2004
Handling	Even very low concentrations of ozone can be harmful to the upper respiratory tract and the lungs.	CCOHS 2004
Handling	ozone is a toxic gas	U.S. EPA 1999
Corrosivity	Attacks most metals including iron and mild steel.	CCOHS 2004
Corrosivity	Hyprobromous acid will have little effect, which is what will be the result of controlled application of ozone; Oxidation of the steel if ozone application is not controlled	Jackson 2003
Corrosivity	highly corrosive	U.S. EPA 1999
Power Requirements	Usually single-phase 115/230 vac. Possibly three-phase 460 vac.	Jackson 2003
Power Requirements	rate of 8 to 17 kWhr/kg O3	U.S. EPA 1999
Maintenance	Semi-annual service if the gas supply and ozonator units. Ususally 1 day twice per year.	Jackson 2003
Maintenance	Regular visual inspections and reading the maintenance log. Annual change out of Ionz cells and chlorine generators.	Stewart 2003

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European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
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USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
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### Citations

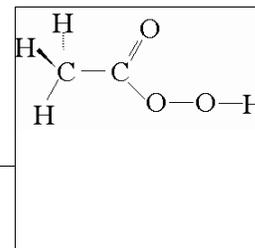
Biswas, K, S Craik, DW Smith, M Belosevic. 2003. CCOHS, , . 2004.	Synergistic inactivation of <i>Cryptosporidium parvum</i> using ozone followed by free chlorine in natural water Cheminfo Profile for Ozone	Water Research 37: 4737-4747 <a href="http://www.intox.org/databank/documents/chemical/ozon/e/cie774.htm">http://www.intox.org/databank/documents/chemical/ozon/e/cie774.htm</a> : -
Clark, RM, Sivagenesan, M., Rice, E. W., and Chen, J. 2002. Cowley, G, . 1999.	Development of a Ct equation for the inactivation of <i>Cryptosporidium</i> oocysts with ozone Disinfection with Chlorine Dioxide	Water Research 36: 3141-3149 Sterling Pulp Chemicals : 1-9
Gehr, R, M Wagner, P Veerasubramanian, P Payment. 2003. Hass, CN, B Kaymak. 2003.	Disinfection efficiency acid, UV and ozone after enhanced primary treatment of municipal wastewater Effect of Initial Microbial Density on Inactivation of <i>Giardia Muris</i> by Ozone	Water Research 37: 4573-4586 Water Research 37: 2980-2988
Jackson, J, . 2003. Korich, DG, JR Mead, MS Madore, NA Sinclair, CR Sterling. 1990. Oemcke, D, . 1999.	Telephone conversation with James Jackson Effects of Ozone, Chlorine Dioxide, Chlorine, and Monochloramine on <i>Cryptosporidium parvum</i> Oocyst Viability The Treatment of Ships' Ballast Water	GDT Corporation : - Applied and Environmental Microbiology 56: 1423-1428 EcoPorts Monograph Series 18: -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Stewart, J, . 2003.	Telephone conversation with Jon Stewart, Vice President of Sales	Marine Environmental Partners : -
Sugita, H, T Asai, K Hayashi, T Mitsuya, K Amanuma, Y Deguchi. 1992. U.S. EPA, , . 1999.	Application of Ozone Disinfection to Remove <i>Enterococcus seriolicida</i> , <i>Pasteurella piscicida</i> , and <i>Vibrio anguillarum</i> from Seawater Alternative Disinfectants and Oxidants Guidance	Applied Environmental Microbiology 58: 4072-4075 EPA Report 815-R-99-014 : -

## Peracetic Acid (Peroxyacetic Acid)



**CAS\_#** 79-21-0

Available as a liquid.



**Other Names** Acetic peroxide; Acetyl hydroperoxide; Ethaneperoxoic acid; Monoperacetic acid; Peroxoacetic acid; Peroxyacetic acid

**Trade\_Names** Peraclean®

Physiochemical Properties	Value or Comment	Citation
Physical State	liquid based on peroxy acetic acid	Fuchs 2001
pH	pH of treated sea water is recuded from 8.2 to 6.1, due to acidic properties of peraclean	Fuchs 2001
Solubility in water	very soluble in water	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
brine shrimp, Artemia salina, at four stages	levels above 350 ppm resulted in 100% mortality of all Artemia live stages.	Fuchs 2001
coliforms	Intial concentration of 0.5-4 mg/L with 8-38 min contact time. Low contact time: 8-12 min, med contatc time: 20-26 min, high contact time of 36-39 min.	Veschetti 2003
Everything down to 40 uM	With filtration, 50 ppm	Fredericks 2003
fish	no LC50; immunological, mortality from EC50	PAN 2004
Fungi	population effects based on EC50	PAN 2004
Giardia muris	90% inactivation has CT of 1.2 mg-min/L and for 99% inactivation CT of 2.6 mg-min/L. When H2O2/O3 ratio is 0.2, 90% inactivation CT of 2.6 mg-min/L and for 99% inactivation CT of 5.2 mg-min/L	U.S. EPA 1999
poliovirus	99% inactivation requires hydrogen peroxide dose of 3,000 mg/L for 360 minutes or 15,000 mg/L for 24 minutes.	U.S. EPA 1999

### Environmental Acceptability

Environmental Acceptibility	not expected to adsorb to suspended solids and sediment in water based on an estimated Koc value of 4	Hazardous Substances Data Bank 2004
Byproducts	expected to hydrolyze slowly to acetic acid and hydrogen peroxide in water	Hazardous Substances Data Bank 2004

### Shipboard Use

Storage	shelf life is at least 1 year. More than 90% of original activity present after 1 year stored at room temp. Available in 220 L drums, 1 m3 IBCs or 20 m3 bulk.	Fuchs 2001
Storage	Store in a cool, dry, well-ventilated location. Separate from acids, alkalies, organic materials, heavy metals. Normally kept refrigerated outside or detached storage is preferred	Hazardous Substances Data Bank 2004
Corrosivity	Corrosive to most metals, including aluminum	Hazardous Substances Data Bank 2004

### Laws and Regulations

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>

Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/register-112.rrr.html">http://sedac.ciesin.org/entri/register/register-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

### Citations

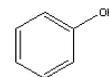
Fredericks, R. . 2003.	Telephone conversation with Richard Fredericks, Vice President	Maritime Solutions : -
Fuchs, R, N. Steiner, I. deWilde, and M. Voigt. 2001.	Peraclean Ocean - a Potential Ballast Water Treatment Option	1st International Ballast Water Treatment R&D Symposium, IMO, London : -
Gehr, R, M Wagner, P Veerasubramanian, P Payment. 2002.	Disinfection Efficiency of Peracetic Acid, UV and Ozone after Enhanced Primary Treatment of Municipal Wastewater	Water Research 37: 4573-4586
Hazardous Substances Data Bank, , . 2004.	Peracetic Acid	National Library of Medicine Toxnet System : -
Oemcke, D, . 1999.	The Treatment of Ships' Ballast Water	EcoPorts Monograph Series 18: -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Sagripanti, J, A Bonifacino. 1996.	Comparative Sporicidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551
Veschetti, E, D. Cutili, L Bonadona, R Briancesco, C Martini, G Cecchini, P anastasi, M Ottaviani. 2003.	Pilot-plant comparative study of peracetic acid and sodium hypochlorite wastewater disinfection	Water Research 37: 78-94

# Phenol



CAS\_# 108-95-2

Available commercially as a liquid, but is a colorless solid when pure.



**Other Names** Phenylic acid; Carboic acid; Benzene, hydroxy-; Phenyl hydroxide; Hydroxybenzene; Oxybenzene; monohydroxy benzene; monophenol; Phenyl alcohol; Phenic Acid; phenol alcohol;

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	colorless acicular crystals or white crystal mass	Hazardous Substances Data Bank 2004
Density	1.071 g/cu cm	Hazardous Substances Data Bank 2004
Solubility in water	1 g/15 ml water	Hazardous Substances Data Bank 2004
Stability	half-life about 9 days in saltwater	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
amphibians	slightly toxic	PAN 2004
annelida	not acutely toxic	PAN 2004
aquatic plants	not acutely toxic	PAN 2004
crustaceans	slightly toxic	PAN 2004
fish	slightly toxic	PAN 2004
molluscs	not acutely toxic	PAN 2004
nematodes and flatworms	not acutely toxic	PAN 2004
phytoplankton	not acutely toxic	PAN 2004
zooplankton	slightly toxic	PAN 2004

**Environmental Acceptability**

Environmental Acceptability	will adsorb to suspended solids and sediments with Koc of 2900 to 3100. Log Kow 1.46	Hazardous Substances Data Bank 2004
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**Shipboard Use**

Storage	Material may be stowed "on deck" or "under deck" on cargo or passenger vessels.	DOT 2002
Storage	Phenol and its solutions are flammable. Stored in closed containers protected from light and area well-ventilated. Prevent overheating and buildup of pressure in phenol containers	Hazardous Substances Data Bank 2004
Handling	strong irritant to tissue. Vapor irritates respiratory system and eyes. Wear protective clothing, gloves, face shields, splash-proof safety goggles.	Hazardous Substances Data Bank 2004
Ventilation	Poison hazard class.	DOT 2002
Ventilation	Concentrations should not exceed 20 mg/cu m.	Hazardous Substances Data Bank 2004

**Laws and Regulations**

Country_Region	Regulation	Web site
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Canada	Canada Shipping Act - Part (XV): Pollutant Substances Regulations (CRC, c. 1458)	<a href="http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html">http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development	<a href="http://sedac.ciesin.org/entri/texts/mar">http://sedac.ciesin.org/entri/texts/mar</a>

	of the Marine and Coastal Environment of the Eastern Africa Region	ine.coastal.east.africa.1985.html
European Union	Existing Substances Regulation 793/93/EEC	<a href="http://ecb.jrc.it/Legislation/1993R0793EC.pdf">http://ecb.jrc.it/Legislation/1993R0793EC.pdf</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
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NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Occupational Safety and Health Act	<a href="http://www4.law.cornell.edu/uscode/29/ch15.html">http://www4.law.cornell.edu/uscode/29/ch15.html</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/register-112.rrr.html">http://sedac.ciesin.org/entri/register/register-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

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Hazardous Substances Data Bank, . . 2004.	Phenol	National Library of Medicine Toxnet System : -
PAN, . . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Sagripanti, J, A Bonifacino. 1996.	Comparative Sporicidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551

**Polyhexamethylene Biguanide (PHMB)**  
proprietary

**CAS\_#** 32289-58-0

Light blue liquid used as microbiocide, fungicide. Also available as a solid in tablet form.

**Other Names** Baquacil; Baquacil SB; poly hexamethylene biguanidine; polyhexamethylene diguanide chlorhydrate; PHMB; Poly (iminocarbonimidoyliminocarbonimidoylimino-1,6-hexanediyl), hydrochloride; Poly (iminoimidocarbonyliminoimidocarbonyliminohexamethylene) hydrochloride

**Trade\_Names** Vantocil 1B; Baquacil SB; Baquacil; Cosmoquil CQPoly Clear Maxi Polish Swimming Pool Sanitizer and Algistat

Physiochemical Properties	Value or Comment	Citation
Physical State	20% active ingredient in water solution	Alden Leeds 2002
pH	4.5 - 6.0	Alden Leeds 2002
Specific gravity	1.04	Alden Leeds 2002
Solubility in water	Soluble	Alden Leeds 2002
Stability	stable product	Alden Leeds 2002

Target Organism	Treatment Dosage	Citation
annelida	LC50: slightly toxic	PAN 2004
fish	LC50: moderately toxic	PAN 2004
zooplankton	EC50: intoxication	PAN 2004

**Environmental Acceptability**

Environmental Acceptability	Material is toxic to fish if released.	Alden Leeds 2002
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**Shipboard Use**

Application	Dosing equipment required	Alden Leeds 2002
Storage	Store in Polyethylene, Polypropylene, Vinyl Polychloride and avoid temperatures below 43F to avoid freezing and do not store near Chlorine, Bromine, Ozone, Sodium Hydroxide, Copper, Silver, and most metals.	Alden Leeds 2002
Handling	Gloves, goggles/glasses, and long sleeves should be worn when handling.	Alden Leeds 2002
Ventilation	Local ventilation adequate	Alden Leeds 2002

**Laws and Regulations**

**Citations**

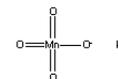
Alden Leeds, , . 2002.	Poly Clear MSDS	<a href="http://www.aldenleeds.com/html/poly_clear.html">http://www.aldenleeds.com/html/poly_clear.html</a> : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -

# Potassium Permanganate

KMnO<sub>4</sub>

CAS\_# 7722-64-7

Dark green solid used as a metal stain as well as an oxidizer in a number of histological and electron microscope laboratory sample preparation procedures. Can also be made into a liquid solution.



## Other Names

## Trade Names

Physiochemical Properties	Value or Comment	Citation
Physical State	crystalline solids	U.S. EPA 1999
pH	better biocide under acidic conditions around pH of 6	U.S. EPA 1999
Density	100 lb/ft <sup>3</sup>	U.S. EPA 1999
Solubility in water	6.4 g/mL at 20 deg C	U.S. EPA 1999
Inactivation	direct oxidation of cell material or specific enzyme destruction.	U.S. EPA 1999

Target Organism	Treatment Dosage	Citation
annelida	LC50: very highly toxic	PAN 2004
asiatic clams	juvenile clam doses range from 1.1 to 4.8 mg/L	U.S. EPA 1999
coliform bacteria	doses of 1 and 2 mg/L needed contact time of 30 minutes. Doses of 3, 4, 5, and 6 mg/L needed contact time of 10 minutes.	U.S. EPA 1999
coliform bacteria	high doses required. For coliforms, 2.5 mg/L for complete inactivation	U.S. EPA 1999
crustaceans	LC50: moderately toxic	PAN 2004
fish	LC50: moderately toxic	PAN 2004
Legionella pneumophila	CT values for 99% (2-log) inactivation at pH 6 were 42.7 mg-min/L at a dose of 1 mg/L (contact time 42.7 min) and 41 mg-min/L at a dose of 5 mg/L (contact time 8.2 min).	U.S. EPA 1999
molluscs	LC50: slightly toxic	PAN 2004
MS-2 bacteriophage	0.5 to 5 mg/L capable of obtaining 2-log inactivation with E. coli as host bacterium. At pH 6 and 8, a 2-log inactivation occurred after a contact time of 52 minutes and a residual of 0.5 mg/L. At residual of 5 mg/L, approx 7 and 13 minutes required for 2-log inactivation at pHs of 8 and 6, respectively.	U.S. EPA 1999
phytoplankton	EC50: biochem, cell, mortality, population	PAN 2004
Vibrio cholerae, Salm. Typhi, and Bact. Flexner	doses of 20 mg/L and contact time of 24 hours needed	U.S. EPA 1999
viruses	50 mg/L and contact time of 2 hours required for poliovirus. Dose of 5 mg/L and contact time of 33 minutes needed for 1-log inactivation of type 1 poliovirus. Higher inactivation rate at 23 deg C than at 7 deg C.	U.S. EPA 1999
zebra mussels	continuous dosing of 0.5 to 2.5 mg/L	U.S. EPA 1999
zooplankton	LC50: highly toxic	PAN 2004

## Environmental Acceptability

Environmental Acceptability	residual levels give water a pink color.	U.S. EPA 1999
Byproducts	manganese dioxide as a precipitant. Microorganisms adsorb to these particles and settled.	U.S. EPA 1999
Inhibitors	Presence of oxidizable organics and inorganics in water reduces disinfection effectiveness.	U.S. EPA 1999
Effectiveness Factor	reaction rates depend on temperature, pH, and dosage. Better biocide under acidic conditions. Higher temperatures enhance bactericidal action. Long contact time required.	U.S. EPA 1999

## Shipboard Use

Generation	generated on-site by using dry crystalline solids with makeup water. Costs ranges from \$1.50 to \$2.00 per pound (1997 costs). May need dry chemical feeder, storage hopper, and dust collector for large systems. Small systems may need dissolver/storage tank with mixers and a metering pump.	U.S. EPA 1999
Storage	Must be stowed "on deck only" on a cargo vessel and on a passenger vessel carrying a number of passengers limited to not more than the larger of 25 passengers or one passenger per each 3 m of overall vessel length, but the material is prohibited on passenger vessels in which the limiting number of passengers is exceeded. Stow separated from ammonium compounds, cyanides, hydrogen peroxide, powdered metal, peroxides and superoxides.	DOT 2002
Storage	easy to store	U.S. EPA 1999

Handling	Oxidizer Hazard Class; medium degree of danger presented by material.	DOT 2002
Handling	can cause serious eye injury and is a skin and inhalation irritant so safety goggles and a face shield, gloves, coveralls and boots should be worn.	U.S. EPA 1999

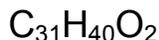
### Laws and Regulations

Country_Region	Regulation	Web site
	East Asian Seas Action Plan	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Canada	Canada Shipping Act - Part (XV): Pollutant Substances Regulations (CRC, c. 1458)	<a href="http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html">http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html</a>
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Mediterranean Sea	Protocol for the Prevention and Elimination of Pollution of the Mediterranean Sea by Dumping from Ships and Aircraft or Incineration at Sea	<a href="http://www.unepmap.gr/pdf/dumping.pdf">http://www.unepmap.gr/pdf/dumping.pdf</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean Region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

## Citations

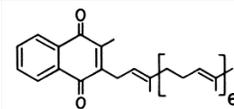
Anderson, WB, CI Mayfield, DG Dixon, PM Huck. 2003.	Endotoxin Inactivation by Selected Drinking Waer Treatment Oxidants	Water Research 37: 4553-4560
DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
U.S. EPA, , . 1999.	Alternative Disinfectants and Oxidants Guidance Manual	EPA 815-R-99-014 : -

## SeaKleen (Vitamin K)



CAS\_# 11032-49-8

Vitamin K2. Available in powder form and used as a biocide.



**Other Names** Menaquinone-4; Menatetrenone

**Trade\_Names** SeaKleen

Physiochemical Properties	Value or Comment	Citation
Physical State	powder	Hyde OptiMarin 2004
Solubility in water	soluble	Hyde OptiMarin 2004
Stability	half life in fresh and salt waer is 18-24 hours depending upon dosage	Hyde OptiMarin 2004
Stability	degrade relatively rapidly with half life of 16-30 hour. Remains in dissolved form in heavy sediment loads.	Wright 2001

Target Organism	Treatment Dosage	Citation
bivalve larvae (zebra mussels)	1 ppm	Wright 2001
dinoflagellates and dinoflagellates cysts	1 ppm. Complete chloroplast destruction within 2 hours.	Wright 2001
Eurytemora, Cyprinodon eggs, dinoflagellates	low dose (1-2 ppm)	Hyde OptiMarin 2004
fish larvae and eggs	1 ppm	Wright 2001
Isochrysis galbana, Neochloris, zebra mussel larva	very low dose (1-2 ppm)	Hyde OptiMarin 2004
Leptocheirus plumulosus	1 ppm	Wright 2001
Oyster mussel larvae, E. coli, Cholera	low dose (1-2 ppm)	Hyde OptiMarin 2004
Vibrio bacteria	1 ppm	Wright 2001

### Environmental Acceptability

Environmental Acceptability	environmental friendly compounds are discharged	Hyde OptiMarin 2004
Environmental Acceptability	does not present toxic threat to receiving waters.	Wright 2001
Byproducts	environmentally friendly compounds	Hyde OptiMarin 2004
Byproducts	non toxic compounds in marine environment	Wright 2001

### Shipboard Use

Generation	delivered as a soluble powder which is dissolved in water prior to being injected into the influent ballast water stream.	Hyde OptiMarin 2004
Application	1-2 g. per metric ton of ballast water. Retail at less than \$0.2 per metric ton of ballast water treated. Dosing equipment retails at \$1600.	Wright 2001
Handling	no special training needed	Hyde OptiMarin 2004
Size	complete system includes a chemical storage and handling system, mixing system, and accurate chemical metering system.	Hyde OptiMarin 2004
Corrosivity	not corrosive to piping and ballast tanks	Hyde OptiMarin 2004

### Laws and Regulations

#### Citations

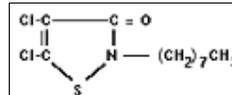
Hyde OptiMarin, , . 2004.	SeaKleen Treatment	<a href="http://www.hydeweb.com/ballast/seakleen.htm">http://www.hydeweb.com/ballast/seakleen.htm</a> : -
Wright, D, Rodger Dawson. 2001.	SeaKleen, a Potential Natural Biocide for Ballast Water Treatment	1st International Ballast Water Treatment R&D Symposium, IMO, London : -

## Sea-Nine

$C_{11}H_{17}Cl_2NOS$

CAS\_# 64359-81-5

4,5-dichloro-2-n-octyl-4-isothiazonline-3-one (DCOI) supplied in 30% solution in xylene as commercial product



**Other Names** 4,5-dichloro-2-n-octyl-3(2H)-isothiazolone; 4,5-dichloro-2-octyl-3(2H)-isothiazolone

**Trade Names** C-9211; DCOI; Duracide L Meldewcide; Kathon 287T; Kathon 5287; Kathon 930; Sea-Nine 211; Sea Nine 211; RH-25287

Physiochemical Properties	Value or Comment	Citation
Physical State	liquid solution	Rohm & Hass 2003
Solubility in water	6.5 mg/L at 20 deg C; log Kow = 2.8; log Koc = 3.2	DEPA 2000
Solubility in water	4.7 g/m <sup>3</sup>	Gandrass 2001
Solubility in water	Koc = 15000 kg/L	Thomas 2003
Stability	biological half-life may be estimated at 14 hours at 12° C ; The aerobic half-life of DCOI is very short in marine systems with sediment and seawater (< 1 hour)	DEPA 2000
Stability	leaching rate = 1 (0.1-5) ug/cm <sup>2</sup> /day	Gandrass 2001
Inactivation	Similar effects whether freshwater or seawater.	DEPA 2000

Target Organism	Treatment Dosage	Citation
Algae	EC50 = 0.0139-0.036 mg/L for 4-5 days exposure	DEPA 2000
Balanus amphitrite	LC50 with active ingredient (ai) = 0.34 ppm	Rohm & Hass 2003
Bay Mussels	48-hour LC50 (embryo) = 2 ug/L; 48-hour LC50 (larvae) = 2 ug/L	Kobayashi 2002
Bluegill	96-hour static LC50 (0.5-1.1 g fish) = 19.8 - 26.7 ppb (highly toxic)	PAN 2004
Brown shrimp	juvenile shrimp 96-hour LC50 = 27 ppb highly toxic	PAN 2004
Crustaceans	EC/LC50 = 0.0047-1.312 mg/L for 2-4 days; NOEC (reproduction) = 0.0006 mg/L (21 days)	DEPA 2000
Daphnia magna	48-hour EC50 = 5.22 ppb for flow-through	PAN 2004
Diatom	96-hour EC50 = 18 ppb	PAN 2004
Ectocarpus siliculosus	(Algae) Minimum inhibitory concentration (MIC) with active ingredient (ai) = 0.2 ppm	Rohm & Hass 2003
Enteromorpha intestinalis	(Algae) Minimum inhibitory concentration (MIC) with active ingredient (ai) = 0.1 ppm	Rohm & Hass 2003
Fiddler crab	15-cm crabs: 96-hour LC50 = 1700 ppb (moderately toxic)	PAN 2004
Fish	LC50 = 0.0027-0.03 mg/L for 4 days; NOEC (early life stage) = 0.006 mg/L for 35 days exposure	DEPA 2000
Mollusca	EC/LC50 = 0.0019-0.850 mg/L for 2-4 days exposure	DEPA 2000
Opossum shrimp	96-hour LC50 = 4.70 ppb (highly toxic)	PAN 2004
Oysters	48-hour EC50 = 24 ug/L	Kobayashi 2002
Protozoa	100% effect at 5 mg/L	DEPA 2000
Sea Urchin	Higher concentrations of Sea-Nine induced cytolysis after cleavage, or produced a delay in development. Cleavage was delayed and development abnormal at medium and lower concentrations.	Kobayashi 2002

### Environmental Acceptability

Environmental Acceptability	DCOI (EC/LC50) are lower than 10 µg/LN-(n-octyl) compared to its metabolite, malomonic acid, is several orders of magnitude lower as the lowest effect concentrations (LC50) are estimated to be between 90 and 160 mg/L.	DEPA 2000
Environmental Acceptability	More degradable and has a lower affinity to sediment as compared to TBT.	Gandrass 2001
Environmental Acceptability	Sea-Nine undergoes rapid biodegradation with a half life of less than an hour.	Thomas 2003
Byproducts	metabolites (N-(n-octyl) malonamic acid and N-(n-octyl) acetamide) and carbon dioxide in seawater	DEPA 2000
Inhibitors	Tolerance towards DCOI was detected during a short-term concentration response of photosynthesis inhibition in the microcosms with phytoplankton communities were exposed to 3.2-10 nM DCOI. The tolerance is possible due to the changes in community structure (changes in taxonomic composition of phytoplankton communities). For 32 nM DCOI, the half life is 2.5 days while for the 100 nM DCOI, the half life is 2.6 days.	Larsen 2003

### Shipboard Use

Storage	In a well ventilated area	Rohm & Hass 2003
Handling	30% solution is corrosive to skin and eyes and slightly toxic by oral and dermal routes of exposure; protective equipment must be worn to avoid contact with skin and eyes; respirator should be worn in areas that may have high vapor concentrations	Rohm & Hass 2003
Ventilation	Explosive-proof local exhaust needed in storage and handling area	Rohm & Hass 2003

### Laws and Regulations

Country_Region	Regulation	Web site
Canada	Canada Shipping Act - Part (XV): Pollutant Substances Regulations (CRC, c. 1458)	<a href="http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html">http://www.tc.gc.ca/acts-regulations/GENERAL/C/csa/regulations/050/csa052/csa52.html</a>

### Citations

DEPA, , . 2000.	Ecotoxicological Assessment of Antifouling Biocides and Nonbiocidal Antifouling Paints	<a href="http://www.mst.dk/udgiv/publications/2000/87-7944-084-3/html/kap03_eng.htm">www.mst.dk/udgiv/publications/2000/87-7944-084-3/html/kap03_eng.htm</a> : -
Gandrass, J, W Salomons (Eds). 2001.	Dredged Material in the Port of Rotterdam - Interface between Rhine Catchment Area and North Sea ( <a href="http://coast.gkss.de/aos/dredged_material/">http://coast.gkss.de/aos/dredged_material/</a> )	GKSS Research Centre : -
Kobayashi, N, H Okamura. 2002.	Effects of new antifouling compounds on the development of sea urchin	Marine Pollution Bulletin : 748-751
Larsen, DK, I Wagner, K Gustavson, VE Forbes, T Lund. 2003.	Long-term effect of Sea-Nine on natural coastal phytoplankton communities assessed by pollution induced community tolerance	Aquatic Toxicology : 35-
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC35757">www.pesticideinfo.org/Detail_Chemical.jsp?Rec_Id=PC35757</a> : -
Rohm & Hass, , . 2003.	Formulating A Coating with SEA-NINE®	<a href="http://www.rohmhaas.com/seanine/index.html">http://www.rohmhaas.com/seanine/index.html</a> : -
Thomas, KV, M McHugh, M Hilton, M Waldock. 2003.	Increased persistence of antifouling paint biocides when associated with paint particles	Environmental Pollution : 153-161

## Silver Ions



**CAS\_#** 15046-91-0

Ag<sup>+</sup> ions in solution or as insoluble silver complexes; can be electrolytically generated; used as a bacteriostat to destroy animal pathogenic bacteria



**Other Names**

**Trade\_Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	aqueous solution or insoluble silver complexes	Hazardous Substances Data Bank 2004
Physical State	aqueous solution	Sistecam SA 2003
pH	1.45	Sistecam SA 2003
Specific gravity	1.091	Sistecam SA 2003
Stability	Stable in solution. Light sensitive.	Sistecam SA 2003

Target Organism	Treatment Dosage	Citation
amphibians	LC50: very highly toxic	PAN 2004
Bacteria	30 ppm induces a 6-log reduction within 2 minutes	Sistecam SA 2003
crustaceans	EC50: accumulation	PAN 2004
fish	LC50: highly toxic	PAN 2004
Fungi	30 ppm induces a 6-log inactivation within 10 minutes	Sistecam SA 2003
molluscs	EC50: accumulation, behavior, biochem, growth, mortality	PAN 2004
phytoplankton	EC50: accumulation, growth, mortality, physiology, population	PAN 2004
Viruses	30 ppm induces a 6-log reduction within 10 minutes	Sistecam SA 2003
zooplankton	LC50: very highly toxic	PAN 2004

**Environmental Acceptability**

Effectiveness Factor	enhances disinfection properties of halogens (chlorine)	Sistecam SA 2003
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**Shipboard Use**

Corrosivity	Not corrosive	Sistecam SA 2003
Ventilation	No irritating fumes	Sistecam SA 2003

**Laws and Regulations**

**Citations**

Abad, FX, RM Pinto, JM Diez, and A Bosch. 1994.	Disinfection of Human Enteric Viruses in Water by Copper and Silver Combination with Low Levels of Chlorine	Applied and Environmental Microbiology : 2377-2383
Hazardous Substances Data Bank, , . 2004.	Silver Compounds	National Library of Medicine Toxnet System : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-
Sistecam SA, , . 2003.	Axenohl™: Advanced Silver Ion Disinfection Technology	<a href="http://www.sistecam.com/Supportdocs/techdatasheet.PDF">http://www.sistecam.com/Supportdocs/techdatasheet.PDF</a> :-

## Sodium Chlorite

ClNaO<sub>2</sub>

CAS\_# 7758-19-2

Bleaching agent as solution or solid flakes



**Other Names** Chlorite (sodium salt); Alclide ld; Chlorous acid, sodium salt;

**Trade\_Names** Neo Silox D

Target Organism	Treatment Dosage	Citation
fish	EC50: mortality	PAN 2004
fish	LC50: not acutely toxic	PAN 2004
fungi	EC50: population	PAN 2004
molluscs	EC50: intoxication, mortality	PAN 2004
phytoplankton	EC50: population	PAN 2004
zooplankton	EC50: intoxication, mortality	PAN 2004
zooplankton	LC50: highly toxic	PAN 2004

### Environmental Acceptability

### Shipboard Use

Storage	Material may be stowed "on deck" or "under deck" on cargo or passenger vessels. Stow separated from ammonium compounds, cyanides, and powdered metal.	DOT 2002
Handling	Oxidizer hazard class; medium degree of danger presented by the material.	DOT 2002

### Laws and Regulations

Country_Region	Regulation	Web site
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>

### Citations

DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> :-
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-

# Sodium Hypochlorite

NaOCl

CAS\_# 7681-52-9



Industrial solutions available in water solutions containing approximately 12.5-15.75% sodium hypochlorite (12-15% available chlorine) are typically used as a disinfectant in water and wastewater systems.

**Other Names** Bleach; Chlorox; Hypochlorous acid, sodium salt; Javel water; Liquid bleach; Soda bleach; Sodium chloride oxide; Sodium oxychloride; Hychlorite; Sodium Chloride Oxide

**Trade Names** Clorox; Javex

Physiochemical Properties	Value or Comment	Citation
Physical State	liquid	Hill Brothers 2003
pH	12	Hill Brothers 2003
pH	Maximum efficacy near neutral	Sagripanti 1996
Specific gravity	1.07	Hill Brothers 2003
Solubility in water	29.3 g/100 g (0 deg C) in water	Hazardous Substances Data Bank 2004
Solubility in water	100% soluble	Hill Brothers 2003
Stability	Decomposition of sodium hypochlorite takes place within a few seconds with the following salts: ammonium acetate, ammonium carbonate, ammonium nitrate, ammonium oxalate, and ammonium phosphate.	Hazardous Substances Data Bank 2004
Stability	unstable above 40 deg C, in sunlight, or in contact with acid or metals	Hill Brothers 2003
Stability	Decay rate = 0.;89 +/- 0.19 per day (r = 0.85)	Sagripanti 1996
Inactivation	Bacteria and protozoa: breaches the cell wall and attacks nucleus; Viruses: attacks the DNA	Bolek 2003
Inactivation	Attacks mucous membrane (i.e. cell walls) of nitrogen-bearing organisms	Harwell 2003
Inactivation	Breaks up DNA with oxidation	Hill 2003
Inactivation	Production of halogens and injection of ionized air	Stewart 2003

Target Organism	Treatment Dosage	Citation
Bacillus subtilus spores	0.05% inactivated >99.9% upon 30 min exposure at 20 deg C	Sagripanti 1996
crustaceans	LC50: moderately toxic	PAN 2004
Cryptosporidium parvum oocyst	Viability is not affected by 1.05 - 3 % chlorine as sodium hypochlorite for up to 18 hours.	Korich 1990
Everything down to 50uM	≤ 1-2 ppm	Hill 2003
fish	LC50: highly toxic	PAN 2004
Microorganisms	Depends on what is in the water. Ranges from 0.5 ppm to 50 ppm.	Bolek 2003
molluscs	LC50: moderately toxic	PAN 2004
nematodes and flatworms	LC50: slightly toxic	PAN 2004
phytoplankton	LC50: moderately toxic	PAN 2004
VEGETATIVE BACTERIA, VIRUSES		Hazardous Substances Data Bank 2004
zooplankton	LC50: moderately toxic	PAN 2004
Zooplankton	~10 ppm residual achieves 90% reduction after 2 hours treatment compared to control	Gracki 2002
Zooplankton	~10 ppm residual for 2 hours achieved >90% reduction	MI Env Sci Brd 2002
Zooplankton, phytoplankton, viruses, larvae, bact.	Depends on level of harbor pollution. Minimum of 2 ppm and maximum of 18-20 ppm	Harwell 2003

## Environmental Acceptability

Environmental Acceptability	Residual chlorine can be toxic to aquatic organisms.	Gracki 2002
Byproducts	Chlorine; sodium chlorate	CCHOS 2002
Byproducts	Potential for leaching metals from the organic fraction of sediments. Amount of release would depend on contact time, amount of metals bound to sediments, amount of sediment, and fate of metals. Disinfection by-products (e.g., THMs) may form.	Gracki 2002



Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA)	<a href="http://www4.law.cornell.edu/uscode/7/ch6.html">http://www4.law.cornell.edu/uscode/7/ch6.html</a>
USA	Hazardous Materials Regulations (CFR49, Chap I, Subchap. C)	<a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/register-112.rrr.html">http://sedac.ciesin.org/entri/register/register-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

### Citations

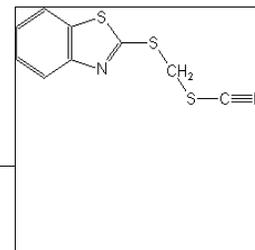
Bolek, K, . 2003.	Telephone conversation with Katie Bolek, Marketing Manager	Miox Corporation : -
CCHOS, , . 2002.	Sodium hypochlorite solutions Chemical Profile	<a href="http://www.intox.org/databank/documents/chemical/sodhypoc/cie351.htm">http://www.intox.org/databank/documents/chemical/sodhypoc/cie351.htm</a> : -
DOT, , . 2002.	Hazardous Materials Table	49 CFR 172.101, <a href="http://www.myregs.com/dotrspa/">http://www.myregs.com/dotrspa/</a> : -
Gracki, JA, RA Everett, H Hack, PF Landrum, DT Long, BJ Premo, SC Raaymakers, GA Stapleton, KG Harrison. 2002.	Critical Review of a Ballast Water Biocides Treatment Demonstration Project Using Copper and Sodium Hypochlorite	Michigan Environmental Science Board, Lansing : -
Harwell, C, . 2003.	Telephone conversation with Christopher Harwell	Electrichlor : -
Hazardous Substances Data Bank, , . 2004.	Sodium Hypochlorite	National Library of Medicine Toxnet System : -
Hill Brothers, , . 2003.	Material Safety Data Sheet	<a href="http://www.desertbrand.com/msds/shypo.htm">http://www.desertbrand.com/msds/shypo.htm</a> : -
Hill, D, . 2003.	Telephone conversation with David Hill	Severn-Trent : -
Korich, DG, JR Mead, MS Madore, NA Sinclair, CR Sterling. 1990.	Effects of Ozone, Chlorine Dioxide, Chlorine, and Monochloramine on <i>Cryptosporidium parvum</i> Oocyst Viability	Applied and Environmental Microbiology 56: 1423-1428
Michigan Environmental Science Board, , . 2002.	Critical Review of a Ballast Water Biocides Treatment Demonstration Project using Copper and Sodium Hypochlorite	A Science Report to Governor John Engler : -
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -
Sagripanti, J, A Bonifacino. 1996.	Comparative Sporicidal Effects of Liquid Chemical Agents	Applied Environmental Microbiology 62: 545-551
Stewart, J, . 2003.	Telephone conversation with Jon Stewart, Vice President of Sales	Marine Environmental Partners : -

## TCMTB



CAS\_# 21564-17-0

reddish viscous and emulsifiable liquid commonly used as a fungicide in soil and seed treatment

**Other Names** 2-(Benzothiazolylthio)methyl thiocyanate; 2-(Thiocyanomethylthio)benzothiazole; 2-(Thiocyanomethylthio)benzothiazole (TCMTB); mercaptobenzothiazolone;**Trade Names** Busan; Busan 30; Busan 44; Buxan 72; Busan 74; TCMTB

### Physiochemical Properties Value or Comment

Physical State	liquid
Solubility in water	practically insoluble in water

### Citation

Cornell University 1985  
Cornell University 1985

### Target Organism Treatment Dosage

Bluegill sunfish	96-hour LC50 = 0.047 ppm using 60% formulation (Busan 72)
fish	very highly toxic
molluscs	slightly toxic
Rainbow trout	96-hour LC50 = 0.029 ppm using 60% formulation (Busan 72)

### Citation

Cornell University 1985  
PAN 2004  
PAN 2004  
Cornell University 1985

### Environmental Acceptability

Environmental Acceptability	Anaerobic half life of 1.5 days for TCMTB and aerobic half life of 31-36 days. TCMTB is rapidly degraded in anaerobic marine sediments when compared to seawater	Thomas 2003
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### Shipboard Use

Handling	Wear rubber gloves and goggles and avoid contact with this product.	Cornell University 1985
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### Laws and Regulations

### Citations

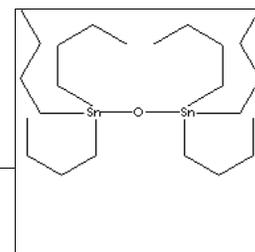
Cornell University, , . 1985.	TCMTB (Busan) Chemical Profile 2/85	<a href="http://pmep.cce.cornell.edu/profiles/">http://pmep.cce.cornell.edu/profiles/</a> :-
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> :-
Thomas, KV, M McHugh, M Hilton, M Waldoock.. 2003.	Increased persistence of antifouling paint biocides when associated with paint particles	Environmental Pollution 123: 153-161

## Tributyltins (TBT)



**CAS\_#** 56-35-9

Organotin exists in the form of monobutyltin (MBT), dibutyltin (DBT), and tributyltin (TBT). TBT degrades into DBT and DBT degrades into MBT.



**Other Names** bis(tributyltin) oxide [CAS\_# indicated]; butinox; hexabutyldistannoxane; TBTO

**Trade Names**

Physiochemical Properties	Value or Comment	Citation
Physical State	liquid	NSC 2004
pH	strong base	NSC 2004
Solubility in water	soluble in hot water	NSC 2004
Inactivation	Chronic toxic effects of TBT such as calcification anomalies in oyster and imposex in gastropods occur at a few ng TBT/L. The toxic concentrations of TBT at embryonic and early life stages of aquatic organisms lie in the range of a few ug/L. TBT into marine environments was generated by washdown during repainting of ships in dry-dock facilities. Antifouling paints applied on boats and ships and effluents from dry-dock facilities are major sources of TBTs. TBT was the highest concentration. TBT accumulated in the surface microlayers poses adverse effects on intertidal organisms, particularly their larvae which are more susceptible to toxic effect.	Hong 2002

Target Organism	Treatment Dosage	Citation
Acartia Tonsa	Environmental concentrations of TBT of 20 to 100 ng/L. Acute toxicity of 0.47 ug/L at 18% salinity and 0.24 ug/L at 28% salinity. Concentrations as low as 0.6 ug/L was found to be toxic for Mercenaria mercenaria. At 0.6 ug/L inhibit growth of O. edulis for 50%	Kusk 1997
Algae	EC50 values between 1-170 nM reported as indicators, based on various approaches employing growth or photosynthesis of algal cultures or phytoplankton communities.	Dahl 1996
Anthocidaris crassispina	10 mg/L induced low rates of fertilization and cleavage, cytolysis occurred. 0.001-1 mg/L: cleavage and normal development rates increased or decreased depending on the actual concentration; development delays and abnormal developments also appeared to be similarly affected. 0.01-0.1 ng/L (low dose) increased normal development rates.	Kobayashi 2002
Hemicentrotus pulcherrimus	10 mg/L induced low rates of fertilization and cleavage, cytolysis occurred. 0.001-1 mg/L: cleavage and normal development rates increased or decreased depending on the actual concentration; development delays and abnormal developments also appeared to be similarly affected. 0.01-0.1 ug/L (low dose) increased normal development rates.	Kobayashi 2002
Mytilus edulis	TBT concentrations increased with decreasing water depth and with length of mussel living in intertidal and subsurface zones.	Hong 2002
Nucillus lapillus	TBT concentrations <0.5 ng/L have been shown to cause imposex.	Connelly 2001
Periphyton	Detected TBT values as the first effect on periphyton communities was 0.3-0.6 nM.	Dahl 1996
T. bronni	10 to 20 ng/L TBT could cause imposex.	Bech 2002
T. clavigera	10 to 20 ng/L TBT could cause imposex.	Bech 2002

### Environmental Acceptability

Environmental Acceptability	TBT degrades to DBT in sediments which is more readily desorbed from the sediments. This desorption and increased mobility would result in an increase of the DBT:TBT ratio over time.	Connelly 2001
Environmental Acceptability	TBT interferes with energy metabolism in both chloroplasts and mitochondria where they act either as ionophores; facilitating the halide/hydroxyl exchange across membrane or as energy transfer inhibitors binding to or in the area of the coupling factor. Both cases, ATP synthesis will be impaired. TBT can also inhibit DNA, RNA, and protein synthesis in rat thymocytes. TBT also inhibits mediated hemolysis of human erythrocytes. EC20 of photosynthesis inhibition: 4-16 nM; EC50 of photosynthesis inhibitions: 16-69 nM.	Dahl 1996
Environmental Acceptability	half life 1 to 2 weeks	Kusk 1997
Byproducts	Reacts with inorganic and organic acids forming non-conducting, water-insoluble compounds.	NSC 2004
Effectiveness Factor	Maximum no effect concentration = 10 ng/L (for all organisms??)	Kobayashi 2002

## Shipboard Use

### Laws and Regulations

Country_Region	Regulation	Web site
Australia	Anti-Fouling Legislation	
Baltic area	Convention on the Protection of the Marine Environment of the Baltic Sea Area (Helsinki Convention)	<a href="http://www.helcom.fi/convention/conventionframe.html">http://www.helcom.fi/convention/conventionframe.html</a>
Canada	Anti-Fouling Legislation	
Central America, Northwest South America	Northeast Pacific Action Plan	<a href="http://www.unep.ch/seas/main/nep/nepape.html">http://www.unep.ch/seas/main/nep/nepape.html</a>
East Asian nations	East Asian Seas Action Plan	
East coastal Africa	Nairobi Convention for the Protection, Management and Development of the Marine and Coastal Environment of the Eastern Africa Region	<a href="http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html">http://sedac.ciesin.org/entri/texts/marine.coastal.east.africa.1985.html</a>
European Union	Biocidal Products Directive 98/8/EC (Anti-fouling)	<a href="http://europa.eu.int/comm/environment/biocides/">http://europa.eu.int/comm/environment/biocides/</a>
Hong Kong	Anti-Fouling Legislation	
IMO	IMO Anti-Fouling Systems Convention	<a href="http://www.imo.org/Conventions/mainframe.asp?topic_id=529">http://www.imo.org/Conventions/mainframe.asp?topic_id=529</a>
Japan	Anti-Fouling Legislation	
Korea	Anti-Fouling Legislation	
Malta	Anti-Fouling Legislation	
Mediterranean Sea	Convention for the Protection of the Marine Environment and the Coastal Region of the Mediterranean (Barcelona Convention)	<a href="http://www.unep.ch/seas/main/med/medconvi.html">http://www.unep.ch/seas/main/med/medconvi.html</a>
Mediterranean Sea	Protocol Concerning Mediterranean Specially Protected Areas	<a href="http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html">http://sedac.ciesin.org/entri/texts/acrc/mspecp.txt.html</a>
Nations bordering the Red Sea or the Gulf of Aden	Jeddah Regional Convention for the Conservation of the Red Sea and Gulf of Aden Environment	<a href="http://www.unep.ch/seas/main/persga/convtext.html">http://www.unep.ch/seas/main/persga/convtext.html</a>
Nations of the South Pacific	Noumea Convention for the Protection of Natural Resources and Environment of the South Pacific Region	
Nations surrounding Persian Gulf	Kuwait Regional Convention for Co-operation on the Protection of the Marine Environment from Pollution	<a href="http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html">http://sedac.ciesin.org/entri/texts/kuwait.marine.pollution.1978.html</a>
NE Atlantic	Convention for the Protection of the Marine Environment of the North-East Atlantic (Paris Convention)	<a href="http://www.ospar.org/eng/html/convention/welcome.html">http://www.ospar.org/eng/html/convention/welcome.html</a>
Netherlands	Anti-Fouling Legislation	
New Zealand	Anti-Fouling Legislation	
North and South Korea, Japan, China, Russian Federation	Northwest Pacific Action Plan	
South Asia	South Asian Seas Action Plan	
Sweden	Anti-Fouling Legislation	
UK	Anti-Fouling Legislation	
United Nations	United Nations Convention on the Law of the Sea	<a href="http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm">http://www.un.org/Depts/los/convention_agreements/convention_agreements.htm</a>
USA	Anti-Fouling Legislation	<a href="http://www4.law.cornell.edu/uscode/">http://www4.law.cornell.edu/uscode/</a>

		33/ch37.html
USA	Clean Water Act	<a href="http://www.epa.gov/region5/water/pdf/ecwa.pdf">http://www.epa.gov/region5/water/pdf/ecwa.pdf</a>
USA	Ocean Dumping Act (MPRSA)	<a href="http://www4.law.cornell.edu/uscode/33/ch27.html">http://www4.law.cornell.edu/uscode/33/ch27.html</a>
USA	Organotin Antifouling Paint Control (33 U.S.C. 2401)	<a href="http://www4.law.cornell.edu/uscode/33/2401.html">http://www4.law.cornell.edu/uscode/33/2401.html</a>
West coastal Africa	Abidjan Convention for Co-operation in the Protection and Development of the Marine and Coastal Environment of the West and Central African Region	<a href="http://sedac.ciesin.org/entri/register/reg-112.rrr.html">http://sedac.ciesin.org/entri/register/reg-112.rrr.html</a>
Western coastal nations of Central and South America	Lima Convention for the Protection of the Marine Environment and Coastal Area of the South-East Pacific	<a href="http://fletcher.tufts.edu/multi/texts/bh809.txt">http://fletcher.tufts.edu/multi/texts/bh809.txt</a>
Wider Caribbean region	Cartagena Convention for the Protection and Development of the Marine Environment of the Wider Caribbean Region	<a href="http://www.cep.unep.org/pubs/legislation/cartxt.html">http://www.cep.unep.org/pubs/legislation/cartxt.html</a>

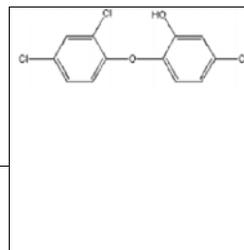
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Bech, M, . 2002.	Imposex and tributyltin contamination as a consequence of the establishment of a marina, and increasing yachting activities at Phuket Island, Thailand	Environmental Pollution 117: 421-429
Connelly, DP, JW Readman, AH Knap, J Davies. 2001.	Contamination of the Coastal Waters of Bermuda by Organotins and the Triazine Herbicide Iragarol 1051	Marine Pollution Bulletin 42: 677-688
Dahl, B, H Blanck. 1996.	Pollution-induced community tolerance (PICT) in periphyton communities established under tri-n-butyltin (TBT) stress in marine microcosms	Aquatic Toxicology : 305-325
Hong, HK, S Takahashi, BY Min, S Tanabe. 2002.	Butyltin residues in blue mussels ( <i>Mytilus edulis</i> ) and arkshells ( <i>Scapharca brughtonii</i> ) collected from Korean coastal waters	Environmental Pollution 117: 475-486
Kobayashi, N, H Okamura. 2002.	Effects of new antifouling compounds on the development of sea urchin	Marine Pollution Bulletin : 748-751
Kusk, KO, S Petersen. 1997.	Acute and Chronic Toxicity of Tributyltin and Linear Alkylbenzene Sulfonate to the Marine Copepod <i>Acartia Tonsa</i>	Environmental Toxicology and Chemistry 16: 1629-1633
NSC, , . 2004.	Tributyltin and Associated Chemicals Backgrounder	<a href="http://www.nsc.org/library/chemical/tributyl.htm">www.nsc.org/library/chemical/tributyl.htm</a> : -

## Triclosan

C<sub>12</sub>H<sub>7</sub>Cl<sub>3</sub>O<sub>2</sub>

CAS\_# 3380-34-5



chlorinated phenol used as an antimicrobial agent, which is widely used in personal care products such as shampoos, soaps, cosmetics, lotions and toothpaste.

**Other Names** TCS, 5-chloro-2-(2,4-dichloro-phenoxy)-phenol, Phenol, 5-chloro-2-(2,4-dichlorophenoxy)-

**Trade\_Names** Aquasept, CH-3635, Gamophen, Lexol 300, Irgasan DP-300, Irgasan, Sapoderm, SterZac

Physiochemical Properties	Value or Comment	Citation
Solubility in water	12 mg/L; log Kow = 4.8; Koc = 47,454 mL/g	Danish EPA 2003
Solubility in water	10 mg/L in distilled water at 20 C	McAvoy 2002
Stability	degradable under aerobic conditions but only little or no removal of Triclosan occurred during anaerobic sludge digestion	Danish EPA 2003
Inactivation	does not affect the treatment processes at levels up to 2 mg/L in the influent	Danish EPA 2003

Target Organism	Treatment Dosage	Citation
fish	highly toxic	PAN 2004
gram negative and gram positive bacteria	exhibits a broad-spectrum bacteriostatic activity	McAvoy 2002
zooplankton (water flea 24-hr)	48-hr EC50 intoxication at min conc of 390 ug/L and max conc of 560 ug/L and mean of 180 ug/L	PAN 2004

### Environmental Acceptability

Environmental Acceptability	auatic photolysis: 41 min. half-life at pH 7 and 25°C	Danish EPA 2003
Environmental Acceptability	rapidly biodegradable in the soil environment half life from 15-35 days	McAvoy 2002
Byproducts	may be biotransformed to a more slowly degradable methoxy-triclosan(TCS-Ome; 5-chloro-2-[2,4-dichloro-phenoxy]-anisole) intermediate in wastewater treatment system. Exposure concentrations of TCS and its biotransformation by-products are expected to be low in the aquatic environment.	McAvoy 2002

### Shipboard Use

### Laws and Regulations

### Citations

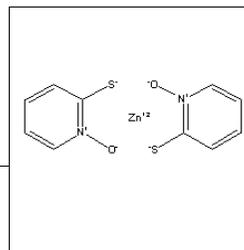
Danish EPA, , . 2003.	Fate and Effects of Triclosan	Environmental Project no. 861 <a href="http://www.mst.dk/">http://www.mst.dk/</a> : -
McAvoy, D, B Schatowitz, M Jacob, A Hauk, WS Eckhoff. 2002.	Measurement of Triclosan in Wastewater Treatment Systems	Environmental Toxicology 21: 1323-1329
PAN, , . 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org/">http://www.pesticideinfo.org/</a> : -

## Zinc Pyrithione

$C_{10}H_8N_2O_2S_2Zn$

CAS\_# 013463-41-

Available as a solid.



**Other Names** Pyrithione zinc; Zinc 2-mercaptopyridine N-oxide; Zinc pyridine-2-thiol 1-oxide; Zinc 1-hydroxy-2-pyridinethione; 2-Mercaptopyridine-1-oxide, zinc salt; Zinc, bis(1-hydroxy-2(1H)-pyridinethionato)-(8Cl)

### Trade\_Names

Physiochemical Properties	Value or Comment	Citation
Physical State	powder form	Hazardous Substances Data Bank 2004
Solubility in water	not soluble	Hazardous Substances Data Bank 2004

Target Organism	Treatment Dosage	Citation
Anthocidaris crassispina	Fertilization and cleavage very high at all concentrations; however, cytolysis or delay in development occurred at 1, 0.1, 0.01, 0.001 pg/L. Various abnormal plutei occurred at concentration of 0.0001 pg/L.	Kobayashi 2002
Hemicentrotus pulcherrimus	Fertilization and cleavage very high at all concentrations; however, cytolysis or delay in development occurred at 1, 0.1, 0.01, 0.001 pg/L. Various abnormal plutei occurred at concentration of 0.0001 pg/L.	Kobayashi 2002

### Environmental Acceptability

### Shipboard Use

### Laws and Regulations

### Citations

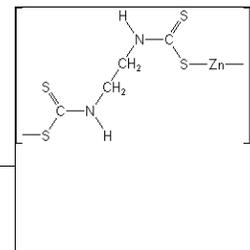
Hazardous Substances Data Bank, . . 2004.	Pyrithione zinc	National Library of Medicine Toxnet System : -
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## Zineb



CAS\_# 12122-67-7

fungicide; Dithiocarbamate, inorganic zinc. Available as a light-colored powder or crystal.



**Other Names** Carbamodithioic acid; 1,2-ethanediybis-; zinc salt; Cineb, Dithane Z-78, Ethylenebis(dithiocarbamic acid); [Ethylene bis(dithiocarbamate)]zinc; Micide; Aaphytora; Aspor; Bercema; Blizene, Carbadine; CHEM zineb; Cineb; Dithane Z; Dithiamina; ENT 14; Novozin; Parzate C; Phyttox; Tanazon; Zidan; Zebtox

**Trade Names** Zineb, Zinebe, Lonacol, Aspor, Chem Zineb, Dipher, Discon Z, Zinosan

Physiochemical Properties	Value or Comment	Citation
Physical State	light-colored powder or crystal	Extension Toxicology Network 1996
Solubility in water	10mg/L at 25 deg C	Extension Toxicology Network 1996
Stability	Unstable in water, hydrolyzes rapidly. Koc is 1000 (estimated); Kow is <1.3010 at 20 deg C	Extension Toxicology Network 1996

Target Organism	Treatment Dosage	Citation
amphibians	LC50: not acutely toxic	PAN 2004
annelida	LC50: highly toxic	PAN 2004
crustaceans	LC50: slightly toxic	PAN 2004
fish	LC50: slightly toxic	PAN 2004
fish	moderately toxic. The 96-hour LC50 in perch is 2 mg/L	Extension Toxicology Network 1996
molluscs	LC50: not acutely toxic	PAN 2004
phytoplankton	EC50: growth, population	PAN 2004
zooplankton	LC50: slightly toxic	PAN 2004

### Environmental Acceptability

Byproducts	ETU and other compounds	Extension Toxicology Network 1996
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### Shipboard Use

Generation	was available in the U.S. as wettable powder and dust formulations. Zineb is formed by combining nabam and zinc sulfate in the spray tank.	Extension Toxicology Network 1996
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### Laws and Regulations

Country_Region	Regulation	Web site
USA	formerly registered in the U.S. as a General Use Pesticide. All tolerances for zineb in agricultural commodities in the U.S. (except grapes used in winemaking) were revoked, effective 12/31/94. The tolerance for grapes in winemaking was revoked in 1997.	

### Citations

Extension Toxicology Network, , 1996.	Pesticide Information Profiles	Oregon State University : -
PAN, , 2004.	Pesticide Action Network Database	<a href="http://www.pesticideinfo.org">http://www.pesticideinfo.org</a> / :-